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CSIR HANDBOOK 1989

COUNCIL OF SCIENTIFIC
& INDUSTRIAL RESEARCH
NEW DELHI-110001

NETWORK OF CSIR INSTITUTIONS

Schematic diagram not to scale

Council of Scientific & Industrial Research
Rafi Marg, New Delhi 110001

CSIR Handbook 1989

CSIR Handbook 1989

COUNCIL OF SCIENTIFIC &
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NEW DELHI 110 001

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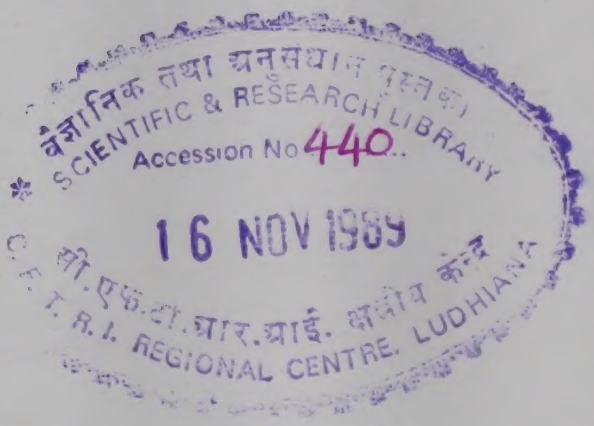
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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

PRESIDENT	Shri Rajiv Gandhi Prime Minister
VICE PRESIDENT	Shri K. R. Narayanan Minister of State for Science & Technology, Atomic Energy, Space, Electronics and Ocean Development
DIRECTOR GENERAL	Dr A. P. Mitra, FRS Secretary Department of Scientific and Industrial Research

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ORGANIZATION

The Council of Scientific & Industrial Research (CSIR), constituted in 1942 by a resolution of the then Central Legislative Assembly, is an autonomous body registered under the Registration of Societies Act XXI of 1860.

The functions assigned to the Council are :

(1) Promotion, guidance and coordination of scientific and industrial research in India, including the institution and financing of specific researches; (2) Establishment or development of and assistance to special institutions or departments of existing institutions for scientific study of problems affecting particular industries and trades; (3) Establishment and award of research studentships and fellowships; (4) Utilization of the results of the researches conducted under the auspices of the Council towards the development of industries in the country; (5) Establishment, maintenance and management of laboratories, workshops, institutes and organizations to further scientific and industrial research and to utilize and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use to Indian industries; (6) Collection and dissemination of information in regard not only to research but also to industrial matters generally; (7) Publication of scientific papers and journals; and (8) Any other activity or activities to promote generally the objects of the resolution. The Department of Scientific and Industrial Research in the Ministry of Science and Technology provides the administrative link between the Government of India and the Society.

Society

The Society of the Council of Scientific & Industrial Research consists of the following members: (1) the Prime Minister of India who shall be the *ex-officio* President of the Society; (2) the Minister-in-charge of the Ministry or Department dealing with the Council of Scientific & Industrial Research who shall be the *ex-officio* Vice President of the Society; (3) Ministers-in-charge of Finance and Industry (*ex-officio*); (4) members of the Governing Body; and (5) Chairman, Advisory Board.

The authorities of the Society are: the Governing Body, the President of the Society, the Vice President of the Society, the Director General of the Council of Scientific & Industrial Re-

search, and such other authorities as may be constituted by the Governing Body. The Director General, Council of Scientific & Industrial Research, is *ex-officio* Secretary and the Principal Executive Officer of the Society. The CSIR Society has the powers of an autonomous organisation. It reviews the progress and performance of CSIR, gives policy directions to the Governing Body of CSIR and approves the annual accounts and report of CSIR.

Governing Body

The affairs and funds of CSIR shall be administered, directed and controlled, subject to the rules and regulations and bye-laws and orders of the Society, by a Governing Body. The Governing Body of the Society for the purpose of Act XXI of 1860 shall consist of the following members: (1) the Director General, Council of Scientific & Industrial Research, *ex-officio* Chairman of the Governing Body;(2) Member Finance, (Secretary to the Government of India for financial matters concerning CSIR); (3) Chairmen of two Technical Advisory Boards (TABs); (4) Directors of two CSIR laboratories; (5) Two eminent industrialists with one from the public sector; (6) Three eminent scientists, with one from academia; (7) Heads of two Scientific Departments/Agencies of the Government of India. All nominations to the Governing Body shall be by the President of the Society and for a period of three years.

The Governing Body shall meet as often as may be considered necessary but not less than four times a year.

Advisory Board

A high level Advisory Board (AB) with external experts from scientific, technical, social science and industrial fields, provides S&T inputs to the Governing Body; overviews the R&D programmes of CSIR to suggest *inter se* priorities and resource allocations and organizes periodic reviews of specific R&D areas and laboratories of CSIR.

The Advisory Board is chaired by an eminent scientist/technologist from outside the CSIR system and has (1) Director General, CSIR, (2) Chairmen of Technical Advisory Boards, (3) Three scientists/technologists/industrialists, (4) An eminent social scientist and (5) Four representatives of scientific departments/agencies of the Government of India, as mem-

bers. Nominations to AB are made by the President of the Society.

Technical Advisory Boards

Technical Advisory Board (TAB) in broad areas of CSIR R&D activities is a forum for involving government departments/ agencies and users in research planning and programme identification. TAB is basically charged with the task of identifying newer R&D areas and evolving long term perspective plans for research priorities. TABs have been established in five broad R&D areas of CSIR. These are for (1) Chemical Sciences & Technology, (2) Biological Sciences & Technology, (3) Physical, Earth & Marine Sciences (including Environment), (4) Engineering Sciences including Electronics and Computers and (5) Material Sciences & Technology.

Each TAB has an eminent Scientist/Technologist from outside the CSIR system as its chairman and a Scientist/Emeritus Scientist of CSIR as convener. The members of TAB consist of (1) Laboratory Directors/Project Coordinators concerned with R&D programmes in the area, (2) Eminent Scientists/ Technologists in the area from ouside CSIR, (3) Representatives of concerned government agencies/departments and users and (4) Special nominee of DG, CSIR.

All nominations to the TABs are made by DG, CSIR for a period of three years. Each TAB in its area of activity (i) undertakes/commissions technological forecasting and prepares long term perspective plans for research priorities and strategies for CSIR and evolves new areas of R&D, (2) identifies, formulates and monitors the progress of specific major R&D programmes, thrust area and mission projects and (3) Suggests net-working of laboratories in implementing the programmes identified.

Research Councils

Research Council (RC) at the laboratory level is a body of distinguished professionals in the area of specialization of the laboratory. RC is to provide thrust, suggest new areas of research and orient R&D programmes in desired direction, apart from serving as a professional vehicle for monitoring of resource allocation and their utilization in each laboratory. RC consists of: (1) Five external experts, one of whom is designated as Chairman, (2) Representatives of concerned scientific depart-

ments/agencies of the Government of India, (3) Director of the laboratory, (4) Senior scientists from another CSIR laboratory and (5) DG, CSIR or his representative as permanent invitee. The chairman and members of the RC are nominated by DG, CSIR while the secretary to the RC is nominated by the Director of the laboratory who also provides the secretarial services for functioning of RC. RCs are to: (1) Advise and recommend the formulation of research programmes of the laboratory keeping the Five Year Plans and national priorities in view, (2) Conduct periodic reviews of the research activities, assess the progress of the research programmes and advise on future directions, (3) Advise on fostering linkages between the laboratory and academic institutions, other research organizations, industry and potential clients. RCs have the power to: (1) Constitute Selection Committees and Assessment Committees/ Peer Groups for selection, merit and assessment promotions, from an approved panel of experts for all the S&T staff, (2) Recommend the resource allocations for major R&D activities of the laboratory, (3) Approve contract R&D programmes envisaging charges of over Rs 50 lakh and (4) Recommend devolution of necessary powers to the project leaders for the proper implementation of the research programmes.

Management Councils

The Management Council, also at the laboratory level, manages the affairs of the laboratory within the framework of rules, regulations, directions and guidelines issued by DG, CSIR, GB and the Society. The Chairman of Management Council (MC) is the Director of the laboratory. Other members consist of: (1) Four scientists of the laboratory representing the staff of various age groups, (2) Two scientists of Director level from the same laboratory or senior scientists from other laboratories, (3) Finance & Accounts Officer of the laboratory, (4) Controller of Administration/AO: Member Secretary and (5) DG, CSIR or his nominee as permanent invitee.

Members to the MCs are nominated by DG, CSIR and period of nomination is for three years. MC is to (1) Administer and manage the affairs and environs of the laboratory so as to support the research plan of the laboratory as approved by the Research Council, (2) Serve as appellate for employee grievances, (3) Write off irrecoverable loans of stores and monies within the limits prescribed by CSIR.

HEADQUARTERS

Anusandhan Bhavan
Rafi Marg, New Delhi 110001

Telegram : CONSEARCH

Telephone : 383652, 381251
Telex : 031-65202 &
031-66147 CSIR IN

Director General : Dr A.P. Mitra, M.Sc., D. Phil., F.N.A., F.A.Sc., F.N.A.Sc., F.T.W.A.S., F.R.S.

The Director General, Council of Scientific & Industrial Research, who is also Secretary to the Government of India, Department of Scientific and Industrial Research, Ministry of Science and Technology, is the Principal Executive Officer of the Council and is responsible for the proper administration of its affairs, under the direction and guidance of the President, the Vice President and the Society. His responsibilities include coordinating and exercising general supervision over all scientific and industrial researches and other activities of CSIR.

The Director General is assisted in his work by a secretariat consisting of technical and administrative divisions and units, viz. Planning, S&T Personnel, Technology Utilization, Extramural Research, International Collaboration, Information & Public Relations, Administration, and Finance.

The organization chart of the Council is shown on cover page 3.

Planning Division

A vital link in the technical secretariat of CSIR, the Planning Division has the major responsibility of drawing up the five-year and annual plans of the Council, monitoring their implementation and evaluating the goals achieved. It consolidates and compiles the plans of CSIR and its laboratories and interacts with the Planning Commission so as to relate the Council's programmes with the socio-economic goals laid down in the national plans. In this task, it also considers the plans of other S&T agencies/departments, etc. with a view to achieving compatibility of the CSIR plans with the national plans in different sectors, and with the development programmes of different departments/ministries/public sector undertakings, etc. The division also interacts with different agencies and ministries/departments of the Government of India in connec-

tion of grant-in-aid support for programmes to be undertaken by different CSIR laboratories. It also takes the initiative in identifying groups of laboratories which can undertake tasks as part of national and technological missions, and coordinates implementation of such programmes.

The division compiles and brings out the CSIR annual reports, produces special technical reports as inputs to the Cabinet summaries and reports of DST and other departments/ministries. Keeping in view the trends of research in science and technology, the Division identifies areas needing higher priorities and thrust, and allocates necessary resources.

It is also concerned with the development of techniques for planning, resource allocation, assigning of priorities, and research management, based on systems approach. The division helps in inter-agency and inter-laboratory coordination, particularly with respect to national S & T missions, CSIR Thrust Area Programmes, etc. It provides technical back-up to DG, CSIR and members of Peer Review Committees for review and allocation of resources on medium term basis, say three years, and further undertakes mid-term appraisal of plans of CSIR.

The division maintains constant interaction with the management of laboratories through participation in their research councils and finance sub-committees, leading to the evolution of appropriate policies, plans and programmes. The division interacts with TABs to evolve appropriate plans and programmes. The division has the responsibility of processing all proposals for new laboratories/centres/divisions/units, etc. in CSIR.

Division for Scientific & Technical Personnel*

The division is entrusted with the responsibility of: (a) operation and maintenance of the Indians Trained Abroad Register, (b) operation of the Scientists' Pool Scheme, (c) running of the TOKTEN (Transfer of Knowledge/Know-how Through Expatriate Nationals) project, and (d) compilation, analysis and publication of manpower data.

National Register

Indian scientific and technical personnel who possess either a degree in science or a diploma in engineering, technology or

*Located in CSIR Complex, Pusa, New Delhi 110012

medicine as the minimum qualification and have stayed abroad for a minimum period of six months for study, research, training or employment are registered in the Indians Trained Abroad Register. However, most of the registrants are highly qualified personnel. Those who possess Ph.D./M.Tech./M.D. or equivalent qualifications are automatically considered for selection to the Scientists' Pool. In addition, those who possess doctorate degrees in arts, humanities and social sciences are also registered for the purpose of consideration for selection to the Scientists' Pool. A total number of about 25,000 Indian scientific and technical personnel have been registered since 1957 to date. During 1986-87, 383 scientific and technical personnel, 8 social scientists and one person belonging to Business Administration were enrolled in the Indians Trained Abroad Register.

Scientists' Pool

The Scientists' Pool scheme was initiated by the Government of India in 1958 to provide temporary placement to well-qualified Indian scientists, engineers, technologists and medical personnel, not holding any employment in India. The Pool is primarily meant for persons returning from foreign countries, but persons who have not been abroad and possess outstanding academic record and have not been able to secure regular employment are also eligible for consideration. Persons selected to the Pool are placed in universities/IITs, other institutions of higher education, national laboratories, other R&D organizations, central and state government departments, public sector undertakings and government hospitals. In several respects the Pool Officers are treated like Class I Officers of CSIR. Persons with high qualifications in Arts, Social Sciences or Humanities are also considered for selection but their number at any time is limited to 40. Pool placement is not a regular employment but is in the nature of a temporary facility to enable a person to work in India while looking for a regular position. Pool appointments are for a period of one to two years. The basic pay of a Pool Officer is fixed between Rs 2200 and Rs 4575 per month depending upon qualifications, experience, research publications and performance in the interview. No annual increments are allowed during the Pool tenure.

Since its inception, a total of 16,942 personnel have been selected to the Scientists' Pool. Out of these, 13,868 have been trained abroad and 3074 have been trained in India: 8229 personnel out of 16,942 selected had joined the Pool. As of 1 December 1987, 619 persons were working in the Scientists' Pool.

The Pool scheme has been reviewed twice, once in 1983 and the second time in 1987 and several improvements have been made as a result of these. A recent study of the Pool scheme has revealed that it gave confidence to the scientists trained abroad to return to India and it enabled them to gain additional experience and improved their prospects of suitable employment in India. Over 80% of Pool Officers were successful in securing regular jobs before leaving the Pool.

TOKTEN

Economic and industrial development at high growth rates of the developing countries requires skilled professionals in various areas at the planning as well as at the implementation stages. In order to help these countries, UNDP initiated a programme called TOKTEN (Transfer of Knowledge/Know-how Through Expatriate Nationals) wherein distinguished professionals/technocrats are invited to undertake short-term assignments in the country of their origin on a voluntary basis. The experts are expected to provide specific technical inputs to strengthen the R&D systems and industrial development of the country in some selected areas depending on their priorities.

This division is operating the TOKTEN-India project on behalf of the Government of India, since its initiation in 1980. Fifty-four TOKTEN consultants came to India in the first phase of the project (1980 to 1982) and provided help to 121 organizations. In the phase II of the project (1985 to 1988) 130 consultants had visited 128 organizations until December 1987. The phase II was operated primarily on the basis of the needs and demands of the Indian organizations. Consultancies have been provided mainly in the areas of electronics, materials science, biomaterials, optoelectronics, instrumentation, membrane science, etc. with a view to improving the functioning and efficiency of the existing operational systems and to encourage technological innovations in key industrial sectors.

This division has built a roster of about 1200 specialists of Indian origin working/settled abroad from whom the TOKTEN consultants are selected from time to time.

The TOKTEN programme has gone through international evaluation in 1983 and in 1987. The project was also reviewed by a committee nominated by the Director General, CSIR, in 1987. As a result of these reviews, the project will be further strengthened and modified to meet the needs of the institutions working in the emerging and frontier areas of science and technology. India hosted the Fourth International TOKTEN Workshop in 1988 in which about 30 developing countries and several UN agencies participated.

Manpower Data

Manpower data pertaining to 7.1 lakh Indian scientific and technical personnel collected during the 1981 general census have been computerized and published in the form of statistical tables. There are separate volumes for the Indian Union and the constituent states and union territories. The tables have been published in 8 volumes which have been distributed to about 400 organizations in India for the purpose of reference and research studies. Manpower data pertaining to about 12 lakh Indian personnel qualified in social sciences, arts, humanities, etc. have also been published in 1987. Some research organizations and state governments have already started using these data for their research studies and for manpower planning.

The *Directory of CSIR Scientists* which was brought out in 1984 in machine readable format has been updated and is being published in six volumes starting from December 1987. The directory has a separate volume on young scientists, containing the biodata of about 1200 scientists of CSIR up to the age of 35 years. The data in the directory have been extensively used for the preparation of CSIR plans and to answer queries within the CSIR and from outside. Some other science departments of the Government of India have initiated plans to bring out directories similar to that of the CSIR.

Four issues of the Bulletin of *Technical Manpower* and four issues of the *Directory of Indian Scientific & Technical Personnel* whose names appear in the National Register, are brought out every year and sent to about 1000 employing organizations.

Data on outturn from universities and colleges from 1947 to 1983 of scientific and technical personnel in the country are being compiled and would be published soon. A study is in progress on the extent of utilization of research fellowships in India.

Biodata of Pool Officers and non-Pool personnel are furnished to employing organizations on specific request to facilitate their regular absorption. In addition, the curricula vitae of about 100 highly qualified Indian scientific and technical personnel located abroad, seeking the Division's assistance in getting regular positions in India, are also circulated to universities, IITs, R&D agencies, public sector industrial undertakings, private sector industries and hospitals with a view to helping them in securing jobs.

Technology Utilisation Division

The Technology Utilisation Division (TUD) is concerned with: (1) promoting the marketing and utilization of CSIR's knowledge-base, expertise and facilities through enhanced linkages with industrial organizations, consulting and design organisations, financial institutions and other potential users; (2) coordinating with CSIR laboratories and interfacing with the National Research and Development Corporation and other agencies for commercializing CSIR's know-how; (3) seeking protection for CSIR's know-how vis-a-vis import of technology through participation in concerned interministerial committees dealing with industrial approvals, viz. Licensing Committee, Technical Evaluation Committee, Foreign Investment Board, Projects Approval Board, and Special Approval Committee for Non-resident Indians; (4) ensuring legal protection to CSIR's intellectual property through legal instruments and drafting of legal agreements for contract research; (5) maintaining information system on CSIR's research output and its utilization; (6) preparing documentation pertaining to CSIR's research results – their utilisation and impact on various sectors of the economy.

The Polytechnology Transfer Centres set up in nine state capitals, to assist the local industrial units in identification and solving of their scientific and technological problems function under the auspices of TUD.

The Patent Unit of TUD secures for CSIR's R&D output, intellectual property rights through obtaining Indian and For-

eign letters of patents, registration of designs, etc. and guards against infringement of the rights secured.

TUD brings out a quarterly information bulletin, *Technology Awareness Service* to disseminate information on CSIR's research output; this is also published in *Research and Industry*, brought out by the Publications & Information Directorate, New Delhi.

Extramural Research Division*

The CSIR supports extramural research in universities and other institutions of higher learning primarily by providing grants for research schemes — an activity started by CSIR since its inception in 1942 and by providing fellowships and associateships to bright young researchers. This sustained assistance by CSIR has considerably contributed to the pursuit and progress of research activities of both pure and applied nature in various departments of universities, Indian Institutes of Technology (IITs), post-graduate departments and colleges in the entire spectrum of Science and Technology. It has substantially contributed to the establishment of the scientific and technological base for the balanced growth of R&D in the country and strengthened the infrastructure for the research and training facilities available for specialized manpower development in different fields of science, technology and engineering in academic institutions.

Some of the other schemes for strengthening R&D capabilities of the country are: provision of financial support for conferences in various S&T areas of all India character in significant areas and partial financial support for travel abroad to young scientists not employed on a regular basis, like Research Fellows, Research Associates and Pool Officers.

CSIR supports the cause of popularization of science through regional languages by providing financial support for publication of journals dedicated to this objective and published in regional languages.

The Shanti Swarup Bhatnagar Prizes are now widely recognized as the most prestigious scientific awards of the country. These prizes are available to those who are 45 years or less in age, and practically every awardee has stayed back in the country. This award has therefore also proved to be a powerful

*Located in CSIR Complex, Pusa, New Delhi 110012

incentive for retaining some of our most talented scientists in the country.

The funds provided by CSIR to academic institutions for research have increased from Rs 3.8 lakh in 1955-56 to about Rs 10 crore in 1987-88.

Research Committees

There are at present 16 research committees with members drawn from educational institutions, government research organizations and industrial establishments. The committees are on: (1) Biochemistry, (2) Botany & Zoology, (3) Civil, Structural and Environmental Engineering, (4) Earth Sciences & Mining, (5) Electronics and Instrumentation, (6) Environment, (7) Industrial Chemistry & Chemical Technology, (8) Inorganic and Analytical Chemistry, (9) Mathematical Science, (10) Mechanical/Electrical Engineering & Tribology, (11) Medical Sciences, (12) Metallurgy and Materials, (13) Organic and Medicinal Chemistry, (14) Physics, (15) Physical Chemistry, and (16) Science Technology & Development Studies. The tenure of research committees is usually three years.

The functions of research committees are: (1) To consider research schemes put up for grant and recommend those which need CSIR support; (2) To consider R&D tasks which can be taken up in universities, IITs, etc. keeping in view the CSIR's assigned functions. The committees may also identify newer areas/disciplines and certain long-range research programmes for extended financial support.

Research Schemes

Financial assistance is provided to professors and other experts in universities, IITs, postgraduate institutions, colleges and laboratories attached to industrial firms for undertaking investigations of good quality research projects in the entire spectrum of S&T on the basis of recommendations of the research committees. Generally, the research schemes approved are of relevance to the research programmes of CSIR or are in an emerging area of S&T. The real emphasis is on the quality of the project proposed and submitted to CSIR for consideration. Normally the duration of the project is three years. However, extension up to two years can be considered depending on the quality of work done under the approved project.

Emeritus Scientists Scheme

Superannuated scientists who are active and have made notable contributions are given grants under the Emeritus Scientists Scheme to enable them to pursue research even after retirement. Besides assistance in the form of research fellows and contingencies, an emeritus scientist is given a monthly honorarium of Rs 2500. This facility is extended for five years or till the scientist attains the age of 65 years, whichever is earlier. In the case of outstanding contributions, extension beyond the age of 65 years can also be considered.

Research Fellowships and Associateships

The CSIR grants ad-hoc (direct) research fellowships (instituted in 1958) to afford opportunities to bright young men and women, with brilliant academic records, for getting research training under experienced investigators in the various fields of Science and Technology (including Medical Science). Junior research fellowships are intended to afford an opportunity to young qualified persons to gain experience in methods of scientific research in basic scientific fields. Senior research fellowships are granted to young research workers who have had training in methods of research and have exceptional aptitude for original research as evidenced through their publications in standard journals. The fellowships are tenable in universities and their constituent colleges and the research institutions of the country including those under CSIR

In 1978, the Council initiated a scheme for direct appointment of a limited number of Research Associates in addition to those appointed on the recommendations of research committees in major schemes/research centres/research units. The qualification for research associateship is Ph.D. or an equivalent degree or three years' experience in research, design and development after M.Tech. in engineering/technology. Research Associateships are also offered for working in CSIR laboratories.

The junior research fellowships in basic scientific fields are awarded on the basis of an all India examination conducted each year by the Council. The detailed advertisement including the methodology adopted for the examination and the syllabi on the basis of which examinations are conducted are published in the *Employment News*. The advertisement for la-

teral senior research fellowships and research associateships also appears each year in various newspapers of India giving the required details.

Almost all the universities/institutes of higher learning with science and technology departments receive research grants from CSIR for schemes and fellowships. The number of institutions which received grants during 1984-85 exceeded 400. The number of CSIR research fellows working in different academic institutions at present exceeds 4000 and the number of research schemes sponsored by CSIR in non-CSIR institutions is about 700. The assistance provided by CSIR is directly proportional to the growth and expansion of scientific education/research in the universities/institutes of higher learning.

Shanti Swarup Bhatnagar Prize

To accord recognition to outstanding researches conducted by young scientists and technologists in the country, the Council instituted in 1957 the 'Shanti Swarup Bhatnagar Prize for Science and Technology' in memory of Dr S.S. Bhatnagar, the founder Director of CSIR. The prize is given every year to Indian researchers up to 45 years of age for their outstanding contributions made primarily by work done in India in any field of science (including engineering and technology) during the five years preceding the year of award. At least five prizes, each of Rs 50,000, are awarded annually in physical, chemical, biological, engineering, medical, mathematical and earth sciences.

Scheme for Scheduled Caste/Tribe Students

With a view to motivating bright scheduled caste/scheduled tribe students to take up science studies at +2/Junior college level and exposing them to the excitement of research in important areas of science and technology, CSIR has introduced a new scheme of awards for them. These will be based on performance of talented SC/ST students in science subjects at class X examinations of different state education boards/Central Board of Secondary Education. Each award consists of a cash prize of Rs 3,000 and an invitation to stay at a neighbouring CSIR laboratory at CSIR cost for 10 to 15 days.

Other Schemes

The Council provides partial grants: (1) for organizing symposia/seminars, etc. (2) for bringing out journals in Indian lan-

guages for popularization of science, and (3) travel grants to research scholars for going abroad to present papers and participate in the symposia/conferences, etc. Two hundred twenty-nine agencies were provided grants for organizing symposia, etc; 16 journals in Indian languages were supported for popularization of science, and travel grants were sanctioned to 178 research scholars for going abroad for presenting research papers during 1987.

International Scientific Collaboration

Bilateral Cooperation

With a view to developing closer relations with other friendly countries, in the field of science and technology, CSIR has established formal relationship in the form of bilateral agreements/protocols for exchange of scientists and scientific and technical cooperation.

The Council has exchange of scientists programmes with the following foreign agencies :

- British Council;
- National Science Foundation of USA;
- Centre National de la Recherche Scientifique (CNRS) of France;
- German Academic Exchange Service (DAAD) of FRG; and
- GDR Academy of Sciences.

Besides, the exchange of scientists programmes, CSIR has concluded Scientific and Technical Cooperation Programmes covering specific areas and projects identified for laboratory to laboratory cooperation. The foreign agencies with whom CSIR has such S&T programmes are:

- Czechoslovak Academy of Sciences;
- Polish Academy of Sciences;
- State Committee for Research & Technology, Bulgaria;
- National Council for Science and Technology, Romania;
- Kerforschungasanalage (KFA), FRG;
- Deutsche Forschungs-und Versuchsanstalt fur Luft-und Raumfahrt (DFVLR), FRG;
- Max Planck Society (MPG), FRG;
- Scientific Research Council, Iraq;
- ARE Academy of Scientific Research and Technology, Egypt;

INTERNATIONAL SCIENTIFIC COLLABORATION

UK
Parasitic Diseases
Ultrasonic Instrumentation
Fire Research
Foundation Engineering
Longwall Mining

FRANCE
Petroleum Refining Process
Applied Mathematics

FRG
Biotechnology
Microelectronics
Oceanography
Pyro and Hydrometallurgy

POLAND
Ecology
Physical Acoustics
Regional Tectonics &
Geodynamics

CZECHOSLOVAKIA
Mining, Fermentation
Polymer Chemistry

BULGARIA
Plant Genetics
Atmospheric Corrosion
Contraceptive Vaccine
Ionospheric Research

NETHERLANDS
Safety and Risk Analysis
Biomonitoring and
Ecotoxicology

NORWAY
Marine Geology
Coastal Zone Management

HUNGARY
Biotechnology, Mining, Roads,
Catalysis, Microelectronics

GDR
Solar Physics, Fermentation
Catalysis, Science Policy

ROMANIA
Petroleum Refining

USA
Coal Utilization & Gas Cleanup
Chemotherapy, Malaria & Cancer
Bioactive Substances from
Marine Organisms
Microelectronics of SEM
Woody Biomass and Tissue Culture

USSR
Solar Energy
Anticorrosion Protection
Standardization & Metrology
Lasers
Oceanography (Air-Sea
Interaction, Geo-Traverse)
Essential Oils

THAILAND
Food Technology
Building Research
Pharmaceuticals
Electronics

NEW ZEALAND
Genetic Manipulation
Earthquake Prediction &
Hazard Assessment
Catalysis
Grasslands

NIGERIA
Building Research
Road Research

TURKEY
Polymer Science
Material Preparation &
Characterization

IRAQ
Petroleum Research
Ionospheric & Magnetospheric
Observation and Prediction
Cellulose Research

EGYPT
Petroleum Research
Pharmaceutical Chemistry
Ore Dressing & Beneficiation

JORDAN
Building & Fire Research
Photovoltaics
Computer Software

SUDAN
Building Research
Food Technology
Energy
Medical Research

- Scientific and Technical Research Council (TBTAK), Turkey;
- Nigerian Building & Road Research Institute;
- Royal Scientific Society, Jordan;
- Netherlands Applied Scientific Organisation (TNO);
- Sudan National Council for Research;
- New Zealand Department of Scientific & Industrial Research;
- Thailand Institute of Scientific & Technological Research;
- Institut Francais Du Petrole, (IFP), France;
- National Institutes of Health, USA;
- State Committee for Science & Technology (GKNT), USSR;
- Imperial Cancer Research Fund of UK; and
- National Council of Science & Technology (CONCYTEC), Peru.

The main features of these agreements are : exchange of scientists and experts to ensure interchange of scientific experience, consultations, participation in science conferences and meetings, delivery of lectures, etc.; collaboration on research and development projects of mutual interest identified jointly; offer of fellowship for training young scientists; exchange of scientific and technical information; cooperation among scientific libraries, information centres and scientific institutions for exchange of books, periodicals, etc.

The cooperation is strictly on reciprocal terms with each partner responsible for its expenditure in its local currency.

CSIR is participating in the Indo-US sub-commission on Science & Technology. A number of projects under Science & Technology Initiative (STI) and US-AID have been taken up. Ten projects are also being implemented with assistance from US held rupee funds in India. Assistance amounting to Rs 27 million has so far been received for these projects. These are in the area of energy, i.e. coal-water slurry from direct combustion, woody biomass, tissue culture, chemotherapy of cancer & malaria and active constituents from marine organisms, etc.

Under the Indo-British MoU on S&T, collaborative projects involving British assistance include heat pump, ultrasonic instruments for medical and other purposes, chemotherapy of parasitic diseases, fermentation, longwall mining, foundation engineering and fire research.

The Council also cooperates through the Department of Science and Technology in implementing the inter-governmental

science and technology agreements in relation to areas/items pertaining to CSIR; with the Indian National Science Academy in their bilateral exchange programmes, and with the Department of Culture (Government of India) in implementing some of their cultural exchange programmes.

Cooperation with International Organizations

CSIR represents the Government of India on the Commonwealth Science Council (CSC), London, and the Association for Science Cooperation in Asia (ASCA). It is actively participating in the CSC's regional coordinated research programmes like the Regional Rural Technology Programme and Regional Metrology Programme for Asia & Pacific. Among the prominent CSC projects are: integrated management of water hyacinth (supported also by UNEP), development of small prime-mover, integrated biogas system, and cultivation & processing of medicinal plants; workshops & seminars on these projects were arranged in India in persuance of Indian contribution. CSIR is a member of the International Institute of Refrigeration and World Association of Industrial and Technological Research Organization (WAITRO).

The Council cooperates with the Indian National Commission for Cooperation with UNESCO with regard to the work of the Science Sub-commission of UNESCO, particularly in relation to the Inter-governmental Oceanographic Commission, Scientific Documentation and Information including UNISIST/ASTINFO/APINMAP Programmes, Science Policy, and Ecological, Biological & Geological Sciences.

The United Nations University, with its worldwide network of advanced research and training institutions devoted to pressing global problems of human survival, development and welfare, has associated one of the CSIR laboratories, namely Central Food Technological Research Institute (CFTRI), Mysore, for advanced training and research in post-harvest technology under its World Hunger Programme. The programme provides for multidisciplinary applied training at CFTRI to senior fellows from developing nations in food conservation with special reference to household and the rural sectors through improved techniques and innovations in handling, storage and processing. Another programme concluded with UNU provides for training of UNU fellows in CSIR laboratories in the area of Biotechnology & Microelectronics.

CSIR and International Development Research Centre (IDRC), Canada, have an understanding for training of research scientists in CSIR laboratories and providing expert services from CSIR for IDRC projects in other developing countries.

International Training Programmes of CSIR

Some of the CSIR laboratories conduct regional/international courses/workshops sponsored by UN bodies and CSC from time to time. The courses and the laboratories imparting them are: Unesco regional seminar on scientific, technical and industrial information services (Indian National Scientific Documentation Centre, New Delhi); Unesco short-term course in science editing for countries of South Asia [Publications & Information Directorate (PID), New Delhi]; Unesco regional training course on methods and techniques of exploration geophysics (National Geophysical Research Institute, Hyderabad); International Food Technology Training Centre: Postgraduate course in food technology (CFTRI); and Regional training programme in metrology under CSC Regional Metrology Programme (National Physical Laboratory, New Delhi).

CSIR is actively involved in the S&T cooperation programme of SAARC (South Asian Association for Regional Cooperation). It has so far organized workshops, training programmes and meetings in areas like groundwater exploration, food processing, medicinal plants, lowcost housing, management of leather industry, pesticides and documentation at various CSIR laboratories.

Apart from these training programmes, CSIR laboratories also receive individual trainees from other developing countries under the bilateral ITEC programmes and under sponsorship of specialized UN agencies and CFTC. PID provides training to science editors from developing countries, sponsored by International Development Research Centre, Canada.

CSIR is the implementing agency for the India-UNIDO Transfer of Technology programme between developing countries, signed in December 1972. Under this programme, expert delegations have visited India from developing countries of South and South East Asia, East Africa,

Algeria, Turkey and Andean Group in South America. Such visits have resulted in transfer of technology in some areas like drugs and pharmaceuticals.

International Fellowships/Awards of CSIR

CSIR has instituted and offered its contribution towards some of the fellowships of international organizations: INSA/ COSTED/FASAS Fellowships—CSIR contributes towards INSA-FASAS Fellowships to the members of the Federation of Asian Scientific Academies & Societies (FASAS) members namely: Sri Lanka, Nepal, Philippines, Malaysia, China, Thailand, Pakistan, Bangladesh and Afghanistan for exchange visits of up to three months; CSC Fellowships—CSIR contributes partially towards fellowships awarded by CSC in respect of attachment abroad of Indian fellows and foreign fellows for their attachment in CSIR laboratories; J.C. Bose Award—CSIR has instituted a J.C. Bose travel fellowship award for an Indian Young Scientist to participate in General Assembly meetings of International Union of Radio Sciences (URSI) which is one of the ICSU unions.

UNDP and Bilateral Technical Assistance Programme

CSIR has participated in the UNDP Country Programmes 1972-77, 1978-85 & 1985-90 and various bilateral technical assistance and cooperation programmes of the Government of India through the Ministry of Finance, Department of Economic Affairs. This has been useful in setting up integrated R&D facilities in CSIR laboratories in new priority areas of research with package of assistance consisting of expert services, training facilities and specialized equipment not available in the country with matching counterpart contribution by CSIR for rupee expenditure to cover land, buildings, staff and indigenous equipment. Some of the areas for which assistance has been received from UNDP include microelectronics, hydrostatic extrusion and material synthesis, turbo machinery, bio-engineering, coal gasification, techniques of mineral exploration including kimberlites and use of alternative fuels for IC engines. New projects approved include development of equipment for microelectronics and new catalysts, oceanography and vaccines for leishmaniasis in

biotechnology. Some of the bilaterally funded projects include FRG assistance for setting up pyro and hydro metallurgical facilities for ore agglomeration and towards equipment for standards laboratory including force standards, Norwegian assistance in the area of oceanography towards equipping *RV Gaveshani* for marine mineral exploration programme and coastal zone management and Swiss assistance towards setting up and updating the Precision Instruments Training Centre at CSIO, Chandigarh and Milling Technology Centre at CFTRI, Mysore.

In all, there are 47 UNDP and other bilateral assistance projects (FRG, Swiss, Norwegian and Danish), out of which 30 have since been completed and the remaining 17 projects are at various stages of implementation. The total assistance so far received under the completed projects is of the order of $ 37 million approximately and amount likely to be received under the ongoing and new projects will be $ 12.5 million.

CSIR provides experts for the various UNDP projects and under bilateral assistance to various developing countries. Most of the CSIR laboratories are registered in the Directory of Services of the Technical Cooperation among Developing Countries of UNDP.

Apart from arranging participation of scientists from laboratories of CSIR in important international conferences, CSIR also provides partial financial assistance towards travel for scientists belonging to other research organizations and universities for participation in international scientific conferences which are of direct interest to CSIR and to which CSIR has not deputed any of its own scientist.

Public Relations Unit

The Public Relations Unit (PRU) of CSIR coordinates and organizes the participation of CSIR in national and international science & technology exhibitions/fairs. The Unit also looks after the dissemination of information through the media on achievements and other activities of CSIR which may be of interest to the masses. Regular press interaction meets followed by visits of media people to the laboratories/institutes are also arranged by the Unit, periodically.

Funds of Society

The funds of the Society consist of grants made by the Government of India for furtherance of the objects of the Society; contributions from other sources; income from investment; and receipts of the Society from other sources. The grants made by the Government of India to CSIR are on net basis, i.e. gross expenditure minus receipts.

CSIR ESTABLISHMENTS

CSIR is a network of 39 laboratories/institutions and about 100 field stations spread throughout the country. These laboratories cover a large spectrum of science and technology. Some of the research establishments like National Physical Laboratory, New Delhi and National Chemical Laboratory, Pune, are engaged in research activities which are basic to industrial advancement. Other laboratories deal with the nation's general needs with regard to food, fuel, buildings and roads. Some are concerned with problems of interest to specific industries, as for instance electronics, glass and ceramics, leather, minerals and metals, marine chemicals, drugs, and scientific instruments. There are establishments concerned with research in mechanical engineering, aeronautical engineering, environmental engineering, aromatic and medicinal plants, experimental medicine and toxicology.

The major activities of CSIR can be grouped under three sections, viz. Missions and National Programmes, CSIR Thrust Areas of Expertise and Capability Development.

One of the main functions of the research establishments is to carry out research directed towards effective utilization of India's natural resources for the economic development of the country. Investigations are undertaken with a view to developing new products and processes and techniques to suit indigenous raw materials. Substitutes are sought for materials scarce or in short supply in order to lessen the country's dependence on imports and thus save foreign exchange. Beneficiation techniques are developed for upgrading sub-grade materials for use in industry and for export. Attempts are made to utilize materials regarded as waste and of no value. Considerable amount of project-oriented basic research is also undertaken by the research establishments.

Some of the establishments have the following additional objectives: (1) to study commercial feasibility of the processes developed in the laboratory, (2) to undertake projects sponsored by industry and government, (3) to maintain sophisticated instruments and equipment needed for research and (4) to undertake developmental work for such instruments and equipment.

Facilities are available in the laboratories for the design and fabrication of pilot plants and research equipment. Successful laboratory investigations are carried to the pilot plant stage to establish the feasibility of large-scale manufacture of products and to assess the economics of production. Detailed project reports are prepared for use by industry. Assistance is provided to manufacturers entering new fields by carrying out developmental work and testing of their products, and advising them on how to improve their products. Technical assistance is rendered to industry through testing facilities. The industrial liaison and extension divisions functioning in the laboratories help establish a two-way interchange of ideas between research and industry. These divisions arrange demonstrations of processes and products developed by the laboratories, and issue publications to keep industry informed about developments.

The research establishments also undertake research projects financed by organizations outside India, and maintain close professional collaboration with workers and institutions abroad.

Many research establishments are closely associated with the Bureau of Indian Standards in the framing of specifications for raw materials and finished products and with the preparation of codes of practices. Some of the laboratories also run training courses in special subjects for the benefit of technical personnel employed in industry.

Most of the laboratories have been recognized by one or more of the Indian universities for post-graduate study and research; some collaborate with Indian and foreign universities in research and lecture programmes.

The Publications & Information Directorate and Indian National Scientific Documentation Centre are mainly concerned with the publication and dissemination of scientific and technical information and the National Institute of Science, Technology and Development Studies carries out studies in the fields of science and technology policy and relation of science with society.

A Centre for Mathematical Modelling and Computer Simulation has recently been set up at the National Aeronautical Laboratory, Bangalore.

CSIR Complexes & Polytechnology Transfer Centres

Two CSIR complexes which house extension and field centres of several laboratories function one each at Madras and Delhi. A new complex has been set up at Palampur, Himachal Pradesh.

Nine CSIR polytechnology transfer centres have been set up whose objective is to bridge the communication gap between the technology generator and technology user.

Research Associations

Two research associations, viz. Tea Research Association, Calcutta and Electrical Research and Development Association, Bombay, are functioning under CSIR. These associations undertake on behalf of member firms not only basic and applied research germane to the problems of industry, but also carry out market surveys, consumer trials, and quality control and operational research.

CENTRAL BUILDING RESEARCH INSTITUTE (CBRI)

Roorkee 247667
(Estd 1951)

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Telex: 0597-203

Director : Dr R. K. Bhandari, B.E. M. Tech., D.I.C. (London), Ph.D. (London) F.I.E., F.I.G.S

The institute has been on the forefront of providing S & T back-up to the problems of building and construction industries. New processes, techniques and construction materials have been developed in order to achieve economy and efficiency in construction. The laboratory also undertakes developmental testing and provides technical aid to industry. Transfer of technology, R&D programmes responsive to changing needs, receive hign priorities.

The R&D work of the institute is pursued in seven well defined areas with multidisciplinary input: Architecture and Physical Planning, Building Materials, Building Processes, Plant & Productivity, Efficiency of Buildings, Fire Research, Geotechnical Engineering and Rural Building and Environment. Besides this, there are units related to Information Dissemination, Overseas Collaboration, Development Construction and Extension Activities. In addition, the institute has six extension centres one each at Ahmedabad, Bhopal, Calcutta, Delhi, Hyderabad and Trivandrum.

Major programmes of R&D are currently persued on problems of eco-development in Garhwal Himalayas, rural housing & environment, urban housing and industrial buildings, development of new alternative building materials including those from industrial and agricultural wastes, fire testing facilites and development of various computer software. The institute is directly assisting the Royal Government of Bhutan towards implementation of its national housing programme.

Over the years, the institute has built up expertise and infrastructure to solve a wide variety of challenging problems. Alongwith, current research programme of the institute, consultancy and sponsored projects are also handled.

Geotechnical and soil investigation studies are of prime importance in designing the foundations of huge structures, con-

struction of underground structures, etc. The institute has pioneered the development of under-reamed piles and bored compaction piles which have been economically and successfully utilized for foundations in soils of poor bearing capacity. Recent developments of skirted granular piles and spliced precast piles hold great potential. Significant projects on which work is going on are: foundation investigation and monitoring of substructure of the Taj Mahal and the joint R&D programme of CBRI and BRE, UK on fundamental mechanism of load transfer through piles by recourse to instrumentation and field monitoring on full size piles. For the first time, it has been possible to establish through direct measurement, *inter alia*, the proportion of load shared by the pile bulb under varying conditions of axial load, seasonal changes in the clay ambient to the pile. The results have provided much awaited scientific base for design of such piling systems achieving higher order of economy with confidence .

The institute carried out detailed investigations on geotechnical problems of Garhwal Himalayas through mountain hazard zonation mapping, instrumentation, field monitoring and design and development of innovative control measures, at the request of Department of Environment.

Considerable attention is being paid to the development of techniques for producing good quality bricks from inferior soils, waste fly ash, coal washeries, etc. Development of low temperature cement has been the institute's recent R&D landmark. The temperature of clinkerization has been reduced from 1400°C to 1250°C resulting in 15% saving in energy. Design of lime shaft kiln has been rationalized through mathematical modelling.

Several CBRI's developments have been widely accepted by construction industry. For example, prefabricated roofing and flooring units, which lead to economy in construction cost and time, are being used by the construction agencies. A technique of stone masonry blocks for walling has been adopted by different states, in areas where stone is available in plenty.

In the area of physical and environmental planning, standards evolved by the institute have been utilized by the Bureau of Public Enterprises, Government of India, for regulating the growth and development of new industrial townships in the country. One of the recent examples of this is the plan of Mathura Oil Refinery Township developed by the instiute.

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Computer software has been developed, on thermal performance of building components, solar radiation on horizontal and vertical surfaces, thermal energy distribution and heat flow studies. Climate and weather conditions of nearly 120 stations in India have been studied and analyzed. Data are available for architects and designers to design energy efficient buildings.

To improve the rural environment, various CBRI techniques, e.g. waste water disposal system, pourflush pit latrines, fire and waterproof thatch, have been adopted by various rural development authorities.

The fire research laboratory of the institute has been guiding the manufacturers in the development of fire detectors, fire evaluation and fire fighting devices, dry powders for extinguishing fires and automatic sprinklers.

CBRI has been appointed as consultant to Royal Insurance Corporation of Bhutan to assist them in their large scale housing activity. In the current phase of programme about 800 housing units of various categories are under construction at Phuntsholing and Thimphu. The institute's contribution has been in the areas of town planning, architectural design, structural detailing and introduction of new technologies in their construction. The other projects on which CBRI has offered package technology include (1) proposal for setting up of an industry for production of laterite bricks, and (2) establishment of solar timber seasoning kiln at various places in Bhutan.

The institute has been asked by the Ministry of Human Resources Development, Government of India, to design and coordinate Navodaya Vidyalaya programme, as a nodal agency. A typical NV complex involves about 20 acre of land for school building complex, residential accommodation for students and staff, ancillary spaces like workshop, library, laboratories, dining hall, farming, fishing and biogas plant as applicable to different geo-climate regions. More than 400 such complexes are to be built throughout the country.

The institute has many patented processes under commercial production. These include: semi-mechanized brick making machine including high draught kiln, lime shaft kiln, underreamed skirted granular piles, silicate based water proofing formulations, corrugated roofing sheets, portable paddle type batch concrete mixer, mini climbing crane, etc.

The institute publishes, annual reports newsletters, ab-

stracts and building research notes and special publications on various technologies.

EXTENSION CENTRES

1. CBRI Extension Centre
   6th Floor, Nizam's Palace
   A-2344, Acharya J.C. Bose Road
   Calcutta 700020

2. CBRI Extension Centre
   C/o School of Architecutre
   Navrangpura
   Ahmedabad 380009

3. CBRI Extension Centre
   North T.T. Nagar
   Bhopal 462003

4. CBRI Extension Centre
   C/o National Buildings Organisation
   Nirman Bhawan
   New Delhi 110001

5. CBRI Extension Centre
   Research Station (B&R)
   Errum Manzil
   Hyderabad 500481

6. CBRI Extension Sub-Centre
   c/o Kerala State Housing Board
   Santhinagar
   Trivandrum 695001

CENTRAL DRUG RESEARCH INSTITUTE (CDRI)

Chattar Manzil, Post Box 173, Lucknow 226001
(Estd 1951)

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Telephones 32411-32418 (PABX)
43405 (Director)
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Director : Dr B. N. Dhawan, M.B.B.S., M.D., F.N.A., F.N.A. Med. Sc.

The objectives of the institute are: (1) Development of new drugs and immunizing agents; (2) Development of contraceptive agents; (3) Basic biomedical research; (4) Systematic investigation of terrestrial plants, marine flora and fauna and tranditional remedies for discovery of drugs; (5) Development of technology for bulk drugs and intermediates, fermentation chemicals and biological products; and (6) Dissemination of information about drug research, development and production.

The institute is a multidisciplinary laboratory, having sixteen R&D divisions: Biochemistry, Biopolymers, Botany, Clinical & Experimental Medicine, Endocrinology, Fermentation Technology, Medical Mycology, Medicinal Chemistry, Membrane Biology, Microbiology, Parasitology, Pharmaceutics, Pharmaco-kinetics & Metabolism, Pharmacology, Process Development and Toxicology. Botany Division has a herbarium containing specimens of about 5000 species of medicinal plants.

The technical infrastructure comprises: Biometry & Statistics; Documentation & Library; Drawing & Photomicrography; Glass Blowing; Instruments; Laboratory Animals; Laboratory Engineering Services; Records; and Technical Information, Industrial Liaison & Planning. The Division of Laboratory Animals has a stock of 65,000 animals belonging to 20 species including primates.

The Regional Sophisticated Instruments Centre (RSIC), supported by the Department of Science and Technology (DST), has facilities for spectroscopy (IR, UV, CD, PMR, CMR, mass), gas/high pressure liquid chromatography, elemental analysis, photoelectric polarimetry, atomic absorption spectrometry, flame photometry, liquid scintillation counting, spectrophotofluorometry, amino acid analysis and transmission/scanning electron microscopy. These instrumentation

services are available to universities, research institutions and the pharmaceutical industry.

The National Information Centre for Drugs & Pharmaceuticals (NICDAP), sponsored under the NISSAT plan of Department of Scientific & Industrial Research, caters to information needs of industry, academia and research institutions. The Centre publishes four monthly bulletins: *Current Highlights* (R&D), *Industry Highlights*, *Patent Awareness* and *Current Indian Titles*.

The R&D programme of the institute is organized in short-term and long-term projects grouped into 15 areas: Antifertility, Filariasis and other helminth infections, Malaria, Amoebiasis, Immunology and microbial genetics including cholera and leprosy, Leishmaniasis, Biological screening, Toxicology, Clinical trials, New drug standardization and delivery systems, New leads development, Natural products, Fermentation technology, Process development, and Cardiovascular and nervous system disorders.

In the new drug development programme about 500 new synthetic compounds, 100 plant extracts and 50 marine flora/fauna extracts are screened every year through about 90 *in vitro* and *in vivo* test systems for antifertility, antifilarial, antihookworm, antimalarial, antiamoebic, antileishmanial, antiviral, antimycobacterial, antibacterial, antifungal, anticancer, lipid lowering and pharmacological activities. Active synthetic compounds and natural products are subjected to detailed pharmacology, toxicology, clinical pharmacology and pharmacokinetic study in the institute. Clinical trials of potential drugs are conducted with the collaboration of the Union Ministry of Health and Family Welfare, the Indian Council of Medical Research, medical institutions and hospital centres.

The Prime Minister Shri Rajiv Gandhi released to industry on 31 January 1987 three new drugs and a diagnostic kit developed at the institute. These are: a local anaesthetic (Centbucridine), a neuroleptic (Centbutindole), a hypolipidaemic (Gugulipid) and an immunodiagnostic kit for filariasis.

A serodiagnostic kit for amoebiasis has also been released to industry.

Other potential drugs under development include Centchroman (once-a-week oral nonsteroidal contraceptive, and also for the treatment of advanced cancer of breast), immunoadjuvant 84/246 (for use with antifertility vaccine), compound 82/

437 (antifilarial), 81/470 (anthelmintic), 80/53 (antimalarial for relapsing cases), artemisinine/artether (antimalarial), 85/467 (antiamoebic), *Nyctanthes arbortristis*, iridoside (antileishmanial), coleonol (hypotensive), curcumin (antiinflammatory), bacosides A & B (for improving mental retention capacity), Centpropazine (antidepressant), 80/574 (hypolipidaemic). Clofazimine and dapsone combined tablet, rifampicin sustained release injectible and primaquin transdermal disc have been developed and are found to show encouraging results in laboratory studies.

An attenuated recombinant bivalent cholera vaccine is in Phase I clinical trials and an antileprosy vaccine derived from *Mycobacterium habana* has completed toxicity studies.

Basic research forms an essential component of the new drug development programme and aims at providing leads for development of new drugs and vaccines, besides generating new knowledge. It includes studies on host-parasite interaction, metabolic pathways of parasites, characterization of protective antigens, cloning of toxin coding genes, drug resistance and plasmids, membrane structure and function, synthesis of novel immunomodulators, ligand-receptor interactions, QSAR and computer graphics, peptides and enzyme inhibitors, sugars as synthons for synthesis of biologically active compounds, liposomes, physiology and ultrastructure of the reproductive tract, adrenergic mechanisms in cardiovascular and nervous system, etc.

Schizont antigen of *Plasmodium knowlesi*, a simian malarial parasite, has been found to be suitable for seroepidemiology of human malaria.

Processes have been standardized for about 65 drugs, intermediates and biological products and 48 of these released to industry including the synthetic drugs indomethacin, amitriptyline, cyproheptadine, dapsone, paracetamol, lidocaine, nitrofurans, bumetanide, primaquine, clofazimine, trimethoprim, dextropropoxyphene, lidamidine and pralidoxime iodide; the intermediates 5,6-dimethylbenzimidazole, D-2-aminobutanol, 2-furoic acid and N-methylpiperazine; the biological products peptone and protein hydrolysate; the fermentation chemicals L-ephedrine and polymyxin B; and the plant product L-dopa. Process for the production of *Bacillus sphaericus*, a mosquito larvicide has been scaled up to 1500 litre fermentor, and its formulation is under field trials.

Mini climbing crane developed by CBRI, Roorkee

A view of the Thoppu Housing Scheme of Kerala State Housing Board, using stone masonry blocks for walling and R. C. planks for roofing

Gugulipid tablets (hypolipidaemic) marketed by CIPLA, Bombay, as Guglip (technology developed by CDRI, Lucknow)

Centbucridine (local anaesthetic) marketed by Unichem Laboratories Ltd, Bombay, as Centocain (technology developed by CDRI,Lucknow; the Bombay firm was associated through the clinical trial stage)

D/E band 1 kW CW multicavity klystron : CEERI, Pilani
(know-how transferred to BEL, Bangalore)

Power Darlington transistors developed at CEERI, Pilani

Roller flaker designed and fabricated by CFTRI, Mysore

Wheat mill : CFTRI, Mysore

The institute has linkages with national and international organizations in the areas/projects indicated: Union Ministry of Health and Family Welfare, Indian Council of Medical Research and World Health Organisation—fertility regulation; Walter Reed Army Institute of Research, USA and WHO—malaria; London School of Hygiene and Tropical Medicine, UK—malaria, filariasis and leishmaniasis; Queen Elizabeth College, London—fermentation technology; Stevens Institute of Technology, USA and Bose Institute, Calcutta—bioactive substances from marine flora and fauna; Central Council of Research in Ayurveda and Siddha and ICMR—medicinal plants and traditional remedies; and ICMR—immunodiagnostic assays and reagents.

FIELD UNITS

1. Clinical Pharmacology Unit (CDRI)
   Department of Pharmacology
   Seth G.S. Medical College & K E M Hospital
   Bombay 400012

2. Neuropharmacology Unit (CDRI)
   K.G.'s Medical College
   Lucknow 226003

CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE (CECRI)

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(Estd 1953)

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Director: Prof. S. K. Rangarajan

The main objectives of the institute are: (1) furtherance of basic sciences and (2) development of indigenous technology in the field of electrochemical science and technology. The activities of the institute cover: (a) basic scientific research oriented towards technology development, (b) training and retraining as well as continuing education and (c) technology transfer and entrepreneurial development. The R&D activities are carried out in nine discipline-oriented divisions, namely: (1) Batteries and Power Sources, (2) Electrochemicals and Thermics, (3) Electrohydrometallurgy, (4) Electropyrometallurgy, (5) Electrochemical Materials Science, (6) Electrodics, Electrobiology and Pollution Control, (7) Electrochemical Electronics and Instrumentation, (8) Corrosion Science and Engineering and (9) Industrial Metal Finishing. These divisions are supported by engineering and technical services division. Priority is accorded to research sponsored by public and private sector organizations, and consultancy services are rendered to user departments and industries on the processes developed by the institute as well as on other electrochemical and allied problems.

The institute has carried out pilot plant scale studies for electrolytic magnesium, electrolytic manganese dioxide (EMD), lead dioxide electrodes and their applications, aminoguanidine bicarbonate, anodic phosphating, and etching of aluminium foil for aluminium capacitors. A commercial plant is being set up for the electrolytic production of magnesium metal from sea bitterns. A 30 kA cell for the production of magnesium using waste magnesium chloride obtained from the titanium plant is in operation now at DMRL, Hyderabad. A plant for the production of electrolytic chromium has been set up at Rourkela, with the CECRI technology.

A large laboratory scale unit has been installed in the pre-

mises of an aluminium plant for the extraction of gallium from Bayer's liquor.

In the division of Batteries and Fuel Cells, the development of porous carbon electrodes for air depolarized cells and lead acid batteries for operation at normal and low temperatures are the major achievements. The current research programmes include the development of lithium cells, sodium-sulphur cells, nickel-iron, nickel-zinc and nickel-cadmium batteries, aluminium batteries, alkaline and phosphoric acid fuel cells and maintenance-free lead acid batteries.

In the division of Electrochemicals and Electrothermics, the development of processes for potassium chlorate, ammonium perchlorate and calcium gluconate are some of the achievements. The current programme includes electropolymerization and development of conducting polymers, development of solid polymer electrolyte cells for chloralkali, surface modification of graphite electrodes for arc furnaces and bipolar flow cell for oxidation of sugars.

The achievements of the division of Electrohydrometallurgy include: production know-how for iron powder, electrolytic chromium powder and the recovery of gallium from Bayer's liquor by the amalgam metallurgy route. The present activity includes study of recovery of metal from very dilute solutions by fluidized bed techniques and using rotating cylindrical electrodes.

In the division of Electropyrometallurgy, the main achievements are the development of processes for the production of sodium metal, misch metal and magnesium. The division is currently engaged in the projects on improvements in the processes for production of aluminium by molten salts as well as electrorefining.

The major breakthrough achieved by the division of Electrochemical Materials Science is the development of Titanium Substrate Insoluble Anode (TSIA) which has successfully replaced graphite anodes in the existing chloralkali mercury cell systems. The development of cadmium sulphide photoconductive cells is another important development. The current programme of work includes the development of electrodes and processes for membrane chloralkali cells, luminescent phosphors, photovoltaics and photoelectrochemical devices.

In the division of Electrodics, Electrobiology and Pollution Control, the major achievement is the development of ion se-

lective electrodes for monitoring the pollutants in industrial effluent streams.

The current investigations include electrochemical pollution control, ion selective electrodes for monitoring other pollutants, electroanalytical techniques for process control and electrobiology.

The division of Electrochemical Electronics and Instrumentation provides the essential instrumentation support for achieving process control in the electrochemical processes. Some of the hardware developed and commercialized are: controllers for azodye manufacture, anodic protection system for heat exchangers, corrosion monitoring electrical resistance probe, and paint holiday detector. The present studies are concentrated on measuring and analytical instruments for electrochemical studies.

Corrosion science has been identified as a thrust area by CSIR, and CECRI functions as the lead laboratory for consolidating the R&D programmes carried out by all the CSIR institutions. In the division of Corrosion Science and Engineering, CECRI has carried out a large number of investigations in this vital area, leading to the development of a number of corrosion preventive products. The major achievements of the division are the development of aluminium-based, zinc-based and magnesium-based galvanic anodes, and coatings for the protection of reinforcement rods in bridges. The major projects in the current programme include the electrochemical aspects of corrosion, monitoring and control of corrosion in concrete structures, inhibitors and coatings.

Significant contributions have been made by the division of Industrial Metal Finishing, such as the process for copper plating on stainless steel, and self regulating high speed chromium salt formulation. The projects currently taken up in the division are: electroless plating, continuous plating of metallic wires and foils, surface conversion and paint coatings, plating of precious metals and alloys for electronic industries, and anodizing of aluminium and its alloys.

The institute organizes both long term and short term industry-oriented technology courses in electrochemistry. These training courses are allied to the activities of the nine major R&D divisions and 55 modules have been proposed for the year 1988.

The institute renders assistance to the scientists and others

for doing Ph.D. work in various universities. The institute helps the Alagappa University in running the Postgraduate course in Industrial Electrochemistry, and the Postgraduate Diploma course in Corrosion Engineering and Metal Finishing Technology.

CECRI has built up a good rapport with industrialists and entrepreneurs. Based on the research work in the various divisions of the institute, a total of 137 processes have been developed so far, and 89 processes have been released for commercial exploitation. More than 230 parties have taken the CECRI processes, and 19 processes are in continuous production currently.

The institute has now the proven capacity to provide turnkey technology for: sodium chlorate, potassium chlorate, ammonium perchlorate/potassium perchlorate, calcium gluconate, cathodic protection, anti-corrosive treatment for steel in concrete structures, lead acid batteries, anodizing plant, copper-nickel-chromium plating, magnesium metal, calcium carbide, electrolytic chromium, and electrolytic manganese dioxide. The turnkey package will include project preparation, machinery procurement, plant erection and plant commissioning.

The institute has its specialized extension services at (a) Madras for battery testing and corrosion studies, (b) Mandapam for corrosion testing, (c) Cochin for metal finishing tests, and (d) Tuticorin for marine electrochemical studies.

Besides publishing the annual report, *CECRI News* and memoirs, the institute brings out a monthly *Bulletin of Electrochemistry*. 'Rural Science Forum' of the institute is engaged in taking science and technologies of CECRI and CSIR to the villages.

EXTENSION SERVICES

1. CECRI Madras Unit
   CSIR Complex
   TTTI, Taramani, Madras 600113

   Telegram: CONSEARCH
   Telephones: 412068 & 413856
   Telex: MS-041-6876 CSIR IN

2. CECRI Mandapam Unit
   Corrosion Testing Station
   Mandapam Camp 623519
   Tamilnadu
   Telephone: 62

3. CECRI Cochin Unit
   CSIR Campus
   Industrial Development Plot
   Kalamassery South, Cochin 683109

   Telegram. CECRI-Kalamassery
   Telephone: 5091

4. CECRI Tuticorin Unit
   Offshore Platform &
   Marine Electrochemistry Centre
   Tuticorin Port Trust Area
   Tuticorin 628004

CENTRAL ELECTRONICS ENGINEERING RESEARCH INSTITUTE (CEERI)

Pilani 333031
(Estd 1953)

Telegram: ELECTRONIC Telephone: 142

Director Dr G N Acharya. M Sc (Phy). Ph D (Phy) (Electronics). Dip Electronics (Edinburgh). Dip Tech (Bombay). M I E R E. C. Engg. (UK), F.I.E.T.E., F.I.S.T.E., F.I.E.E. (India)

The institute is concentrating its efforts in three major areas: (1) Electronic systems for industrial and transportation applications, (2) Semiconductor devices covering power devices, microelectronics and hybrid microcircuits, and (3) Microwave tubes required for Defence, Space and Communications. In line with the emerging trends, CEERI is now orienting its activities towards development of integrated electronic systems incorporating Application Specific Integrated Circuits (ASICs), power devices and hybrid microcircuits under the same roof.

Attempts are being made to solve industrial problems to facilitate the transition of industry from the traditional to modern. Sugar and paper industries, with a turnover of several hundred crores of rupees, have been chosen for modernization. Microprocessor-based integrated electronic systems are being developed for modernization of these industries. These projects are financially supported by the Department of Electronics, Government of India. By now, the equipment for automatic *p*H control and pan boiling developed in first phase has been installed in more than 50 sugar factories in the country. A microprocessor-based automatic *p*H control system called MAPCON has been developed for juice clarification processes. MAPCON has three independent control loops to regulate preliming, shockliming and sulphur dioxide through motorized valves, with on-line monitoring of the three *p*H values. The know-how for MAPCON has been released to three industrial undertakings.

A microprocessor-based pan monitoring system called MIPMOS has been developed which computes and displays pan parameters such as purity, brix, supersaturation, on the basis of on-line measurement of a.c. resistivity, temperature, viscosity and level under identical conditions. This system helps reduce the total boiling time and the consumption of water and steam.

Temperature is an important variable in sugar industry which needs continuous measurement and control. Temperature monitoring not only ensures lower energy consumption but improves the quality of final products. An accurate digital temperature indicating and monitoring system called MICRO-TEIMAC has been successfully developed for industrial applications.

CEERI is now expanding its sphere of activities to include a few more process stages in sugar plants. These systems being developed will consist of development work on oxygen sensor. which constitutes one of the critical items for improving boiler efficiency, has reached an advanced stage.

In the area of electronic systems for transportation, CEERI has to its credit a number of achievements, starting with electronic control systems for diesel electric locomotives.

During 1987, a 40 kVA PWM solid state a.c. drive for mining locomotives has been taken up for production by BHEL. During field-trials, this system has indicated more than 30% reduction in battery drain compared to conventional d c. motor drives and faster braking with regeneration used for charging the batteries.

CSIR is now launching an R&D programme for the development of electric vehicles using microprocessor-based a.c. motor drives Participating organizations are CEERI, ARAI-Pune, BHEL-Bhopal, CMERI-Durgapur, RRL-Bhopal, CECRI-Karaikudi, NPL-New Delhi and IGCAR-Kalpakkam.

Darlington power transistors which combine two transistors on the same chip permit higher switching speed requiring no forced commutation circuit. A 100 A, 400 V monolithic power darlington transistor along with the free wheeling diode has been fabricated on a 33 mm silicon wafer at CEERI.

Hybrid microcircuits are known to have highest quality and reliability. They combine active as well as passive electronic devices and integrated circuits on a single substrate of ceramic material, thus shrinking the large size of printed boards manifold. CEERI has the necessary facilities and expertise for design, development and fabrication of HMCs for meeting the stringent requirements of space applications. The Minicircuits Pvt. Ltd, Bangalore, who has taken the know-how on hybrid microcircuits entered regular production during 1987 and has produced HMCs worth about Rs 1 crore.

For the development of large scale integrated circuits,

CEERI has established the basic facilities for computer-aided design, mask making and processing such as diffusion, mask alignment lithography, LPCVD, etc.

In view of the special advantages of PWM a.c. motor drives, CEERI has embarked upon a programme for custom design and development of microchips, specific to the application in electric transportation systems. A delicate 16-bit PWM processor consisting of around 10,000 transistors has been designed as a set of 2 chips. The prototype chips in 6 micron NMOS technology are presently being tested.

In strategic and critical applications for Defence and Communications, microwave tubes play a key role. Most of the requirements of the country are being met by import of these tubes. However, their availability is always uncertain. CEERI is the main R&D organization in the country devoted to this area.

Earlier, Central Electronics Ltd, Sahibabad, had taken CEERI know-how for 500 kW and 1 MW magnetrons, and had successfully established their production. Recently, Bharat Electronics Ltd, Bangalore, has taken the know-how of a 4-cavity klystron amplifier tube in the D/E band 1.7 to 2.4 GHz. CEERI has also successfully developed S-band 400 W M-Carcinotron (for DoE) and 6.0 GHz 20W TWT for ISRO.

Speaker identification and verification system assumes great importance as now more crimes are being committed through networks. CEERI Centre, New Delhi, has undertaken R&D in this area through interaction with users. The New Delhi centre has also developed electronic telephone exchange having a conferencing facility, and audio visual systems having information retrieval and display facility for trade fairs and museums.

Paper and Pulp Industry is undoubtedly one of the priority industries and needs immediate modernization to increase productivity as well as the quality of paper. Microprocessor-based instrumentation systems for on-line measurements of basis weight, moisture and calipre have been developed at CEERI Madras Centre. The integrated equipment called SCANPACK has been installed for field-trials in a commercial paper factory in Tamilnadu.

Recently, CEERI has set up a Centre for modernization of the Paper & Pulp Industry using electronic systems at Madras. Work on this phase has been initiated under a grant-in-aid project of DoE.

As part of the national service, CEERI is periodically organizing specialized workshops, training programmes in electronics such as electronic instrumentation for modernization of sugar industry, desk top computers for management functions in CSIR laboratories, etc.

In line with the current trends, CEERI is progressively making a headway in the development of integrated electronic systems using indigenously designed ASICs and semiconductor devices to meet specific needs. Simultaneously, efforts are being focussed on computer aided design, mathematical modelling and simulation required for various industrial processes and electronic devices.

FIELD STATIONS

1. CEERI Centre
   CSIR Complex, NPL Campus
   New Delhi 110012
   Telegram: CEERICENT
   Telephone: 583172

2. CEERI Centre
   CSIR Complex, Adyar
   Madras 600020
   Telegram: CONSEARCH

CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE (CFTRI)

Cheluvamba Mansion, Mysore 570013
(Estd 1950)

Telegram : FOODSEARCH

Telephone : 22660
Telex : 846-241 FTRI

Director : Dr B.L. Amla, M.Sc., Ph.D.

The principal goal of the institute is to stimulate the growth and productivity of India's food industry through the most efficient utilization of the nation's food resources. In order to fulfil these aims, it undertakes wide range of activities covering the following areas: (1) Development of (i) Food products and processes for optimal utilization of the country's agricultural produce to meet the food needs, (ii) Nutritious food for vulnerable groups of population, (iii) Food processing machinery for indigenous industry, and (iv) Packaging techniques for food materials and processed items; (2) Utilization of residual waste/byproducts of the food industry; (3) Development of export-oriented value added products; (4) Development of integrated systems for post-harvest handling storage and processing and utilization of the agriculture produce. The institute offers a battery of services such as the generation of relevant technology and its industrial application through consultancy services; analysis, testing and evaluation of food materials and their products for purposes of ensuring consumer safety and quality control, particularly for exports; training of personnel for managerial and policy making levels in industry and government; and the retrieval and communication of information with the aid of computers and audio-visual media.

The institute's activities also include the beneficiation of agricultural produce for the manufacture of food additives and fine chemicals of high economic value, development of nutritious foods, and modernizing the preparation of traditional Indian foods through ready-mixes to suit the convenience of the Indian families, particularly for working women.

Other R&D activities with promising future applications currently in progress include synthesis of bio-active sub-

stances with plant growth effect; synthesis of sugar analogues with potential pesticidal activity; preparation of food flavourants, fruit juice concentrates and beverages; tissue culture for high-value crops such as ginger plants with high oleoresin yields; extension of storage life of ripe bananas and chillies by modified atmosphere storage. Studies on Indian confectionery, development of new class of ready-to-eat foods, with specified textures, flavours and extended keeping qualities, improved utilization of oilseeds and edible oils.

Basic research problems under investigation relate to areas such as food additives; chemistry and functionality of carbohydrates and proteins; enzymology and molecular biology; chemical investigations of newer bioactive substances.

During the last 37 years, the institute has undertaken such a wide range of R&D activities, that, today the country can confidently assist ventures on almost any type of industry dealing with food and beverages, for people of all ages, coming from different social strata reflecting varied nutritional requirements and food habits.

The safety evaluation of foods is given due importance. Toxic substances including mycotoxins, pesticide residues, and heavy metals are studied with a view to ensuring food safety and quality.

As a reference centre for food analysis, the institute acts as an appellate laboratory under the provisions of the Prevention of Food Adulteration Act. Under the Fruit Products Order, it analyzes processed fruit and vegetable products for conformity to quality specifications in domestic and export markets.

To develop and scale-up the laboratory scale processes, engineering facilities including design and fabrication of machinery and equipment have been created.

CFTRI serves as an active centre for development of human resources for the food industry and government agencies concerned with food. It runs a two-year postgraduate course to train students from developing countries for the M.Sc. degree in Food Technology of the University of Mysore, and also short courses on different topics for professionals from industry and government agencies. The United Nations University (UNU) has chosen the institute as an associated institution for advanced training and research in post-harvest conservation and processing of food for personnel from developing countries, since November 1976. An International School of Mill-

ing Technology, established in 1981 at the institute, runs a 10-month course in flour milling technology, and short courses for technical personnel.

In recognition of its facilities, services and expertise, CFTRI has been chosen by national and international bodies to be a centre for information on food science and technology.

The institute is consultant to a number of manufacturing concerns and government organizations. It has developed close rapport with different state governments and their Agro-Industries Corporations, and has been assisting them with technical consultancy services for setting up food-based agro industries.

CFTRI's association with United Nations Organisation and agencies including FAO, UNIDO, ESCAP, WHO, ISRD and UNU, and with scientific institutions in other countries under bilateral programmes, highlights its international role.

A wide section of the Indian food industry, by and large, has been benefited by the technological inputs provided by the institute. It covers products, such as cereals and millets, legumes, fruits and vegetables, protein foods, beverages, spices and oleoresins and animal products, as well as disinfestation and storage techniques and various types of equipment and machinery. Out of a total number of over 270 processes developed by CFTRI, about 150 processes have been released to about 1200 enterprises.

CFTRI has the unique distinction of processing buffalo milk into an infant food, which laid the basis for indigenous baby food industry. The country today produces about 50,000 tonnes of baby food valued at 2100 million rupees. 'Amul Baby Food' based on the institute technology has been a popular item in Indian households for more than 25 years. Other brands, such as 'Vijay Spray', based on the same technology have now entered the Indian markets. Thus, processing of buffalo milk for baby food which was once considered a fantasy has become a hard core reality. Over the years, the institute has also developed yet another baby food which is very similar to human milk and can, therefore, easily be digested by babies.

The institute has been a pioneer in harnessing plant proteins to serve as the nutritious base for a variety of food supplements such as energy foods, weaning foods, and Miltone -a vegetable toned milk designed to extend the supply of animal milk. These can meet the needs of vulnerable groups, more

particularly the infants and children who constitute about 20% of India's human population.

Foodgrains—cereals and pulses—provide more than 80% of the nutritional needs of Indian people. Improvement of traditional techniques for increasing the yields of final output, such as rice, *dal*, and flours of wheat/millets has engaged the attention of the institute ever since its early stages of development. For example, improved techniques of parboiling of paddy are helping the industry to slash time and labour costs and increase the output, and offer a better quality rice to the consumer.

Another example is a wheat processing line which makes use of existing machinery—a rice huller, a *chakki* and a sieve—to clean and then grind wheat into products like *atta* and bakery flour. More than 70 entrepreneurs have taken up this know-how to start small units in different parts of the country. Such a set-up would enable small entrepreneurs and cooperatives to meet all their requirements of semi-processed wheat products for conversion into bread, buns and biscuits in the village itself.

Similarly, processing lines, also called mini grain mills, have been developed for milling rice, jowar, bajra and maize for small processing requirements.

The institute's work built up the feature of convenience in the preparation of traditional snack items of India. Instant mixes for quick and effortless preparation of popular breakfast foods such as *idli*, *dosa*, *vada*, *jalebi* and *gulab jamun*, developed more than 20 years ago, are the forerunners of a wide range of convenience foods appearing in Indian markets and have shown a new way to make and enjoy foods at home.

Spices are a major source of export revenue for Indian exchequer earning more than 3000 million rupees every year. India's spice trade is gradually shifting from raw material exports to spice extractives, essential oils and dehydrated green pepper of much higher economic value, all resulting from the institute's R&D efforts. An indigenous spice oleoresin industry has thus developed to offer competition to the enterprises of western countries.

Fully indigenous technologies are now offered for fermentation and drying of cocoa, and production of cocoa mass, cocoa butter, and cocoa powder.

The growth of the fruit processing industry in India owes

much to the technology and consultancy that the institute has provided. The institute has been a Consultant for establishing fruit and vegetable processing plants in many states—Karnataka, Kerala, Bihar, Haryana, Maharashtra, Punjab, Goa and north-eastern states.

During the last two decades, several types of flavour concentrates for orange, lime, and cola beverages have emerged from R&D efforts of CFTRI. The indigenous soft drinks industry which had perished with the promotion of a soft drink put out by a multinational company since 1960 has begun to flourish again with a variety of beverages after the favourable policy decisions based on the institute's know-how. About fifty manufacturers are currently manufacturing 1600 million bottles of soft drinks valued at 1400 million rupees.

The institute has developed several simple and effective methods for protecting foodgrains from microbes, insects and rodents. These have been applied successfully by both public and private sector organizations to minimize food losses in rural/urban households and warehouses in the country. Development of ecologically safe protectants such as pheromones, bacterial spore formulations, activated clays and mineral salt mixtures is a novel approach to infestation control. Scientific and technical infrastructure and expertise have been built at the institute for studying the toxicity of pesticide chemicals and generating data needed for their registration with the Insecticides Board.

Byproduct utilization is an emerging area of R&D at CFTRI. A plant growth substance developed from tea wastes and sugarcane pressmud can become a magic-wand for increasing productivity of a number of agricultural crops. Foliar spraying of this chemical in milligram quantities per hectare increases the yield of the tea leaves by 25 to 40 per cent and also minimizes the problem of dormancy in unproductive tea plantations of the north-eastern region of the country.

Another success story is the development of techniques to stabilize the rice bran, immediately after milling, so that it can be used for production of high quality cooking oil. Commercial applications of these techniques may lead to the substantial utilization of the oil present in the bran.

A number of gadgets have been developed for home or cottage scale uses. The institute has devised a hand-operated machine which can process 50-75 kg of pulses per hour with a

much higher yield than that of a commonly used *chakki*.

Continuous process for producing cereal flakes from rice, jowar, maize and bajra has made it possible to increase yield and quality and save time and labour with CFTRI know-how.

The greatest impact on industry in recent months seems to have been made by the *papad* making machine which can stamp out *papads* of any desired size at the rate of 600 per hour.

The institute publishes (1) *Food Technology Abstracts* (monthly) containing abstracts under 28 classified heads; (2) *Food Digest* (quarterly) containing information on raw materials, processes, products, equipment, machinery, packaging, commercial intelligence and food regulations; (3) *Food Patents* (quarterly) containing information on patents published the world over on food and allied products; (4) *Techno-Economic News* (cyclostyled, monthly); and (5) *CFTRI Newsletter* (bi-monthly) in English, Hindi and Kannada.

REGIONAL CENTRES

1. CFTRI Regional Centre
   Bhavan's College Campus
   Andheri West, Bombay 400058
   Telegram: FOODSEARCH BOMBAY

2. CFTRI Regional Centre
   Pilot Plant Building of CDRI
   Opp. High Court, Lucknow 226001
   Telegram: FOODSEARCH LUCKNOW

3. CFTRI Regional Centre
   C-25, Industrial Estate
   Sanatnagar, Hyderabad 500018
   Telegram: FOODSEARCH HYDERABAD

4. CFTRI Regional Centre
   Fisheries College Campus
   Hoige Bazar, Mangalore 575001
   Telegram: FOODSEARCH MANGALORE

5. CFTRI Regional Centre
   PU Gurunanak Engineering College
   G.T. Road, Ludhiana 141006
   Telegram: FOODSEARCH LUDHIANA

6. CFTRI Regional Centre
   Guru Bungalow, Chandmara Road
   Nagpur 440013
   Telegram: FOODSEARCH NAGPUR

CENTRAL FUEL RESEARCH INSTITUTE (CFRI)

P.O. FRI, Dist. Dhanbad 828108
(Estd 1950)

Telegram: RESEARCH, FRI

Telephones: Jharia 60141, 61853 & 61807
Telex: 0629-201

Director: Dr R. Haque, M.Sc. (Tech), Ph.D. (Birmingham)

The institute undertakes research, both fundamental and applied, on India's fuel resources, especially coal and lignite, with a view to assessing their quality and potential uses in the most efficient manner.

The R&D activities of CFRI cover broadly the following eight areas/divisions: (1) Resources quality assessment, including geology and petrography of coal; (2) Preparation of coal: coal washing, demineralization (by physical and chemical processes), briquetting, pelletization, flocculation; (3) Technology for direct use of coal: combustion (specially fluid-bed), carbon artefacts for electrothermal and chemical industries; (4) Conversion of coal: carbonization (high and low temperature, fluid-bed), gasification, oxidation (including coal fertilizer), solvent extraction, production of synthetic liquid fuels and chemicals from coal (both by direct hydrogenation and via gasification route); (5) Product improvement and valorization, including recovery and purification of coaltar chemicals and utilization of industrial and agricultural wastes; (6) Process development and scale-up studies; (7) Supporting R&D activities: basic research relating to nature and constitution of coal, coal science and systematics, spontaneous combustion, catalysts and absorbents, applied statistics, chemical and instrumental analysis including standardization of methods of analysis and testing of coals on behalf of ISI; and (8) Supporting technical activities: engineering services, technical aid to industry, technology transfer and consultancy, techno-economic evaluation, library, documentation, reprography, coordination, publications, liaison, planning, monitoring and costing of projects.

Fischer-Tropsch synthesis process development unit (coal to oil, 5 litres/day) at CFRI, Dhanbad

Chromium plant (30 tonnes/annum) of Indian Chrome Metals Pvt. Ltd, Roorkee, with CECRI technology

Chunk of optical glass : CGCRI, Calcutta

Modified chemical vapour deposition lathe for fabricating preforms for optical communication fibres : CGCRI, Calcutta

Oxidation ditch for tannery effluent treatment at Ambur (Tamil Nadu) : CLRI, Madras

Application of robot for cutting of sheet metal in steel plants : CMERI, Durgapur

Artemisia annua introduced by CIMAP in Kashmir

The institute has the following pilot plant facilities/process development units (PDUs) for bulk testing of coal/coal-derived fuels: Low pressure briquetting plant (1.5 tonnes/hr); High pressure briquetting plant (1.25 tonnes/hr); Oil-fired high temperature carbonization plant (1.1 tonnes coal per charge); Electrically heated test coke oven (250 kg coal carbonization per charge); Low temperature carbonization plant with byproducts recovery unit (20-30 tonnes/day); Powdered coal Koppers-Totzak gasification plant (125 kg/hr); High pressure Lurgi gasification plant (0.8 tonne/hr coal throughput) including Linde oxygen plant and high pressure boiler; Fluid-bed coal combustion plant (2 tonnes/hr steam); Fluid-bed combustor cum air heater (75 kg/hr coal throughput); High pressure coal hydrogenation plant (slurry phase, input 0.5 tonne/day coal); Pelletization plant (1 tonne/hr); Formed coke briquetting plant (1 tonne/hr); Formed coke briquette curing plant (8 tonnes/day); Pneumatic separator unit for selective preparation of coal (2 tonnes/hr); Flotation cells (40 kg/hr); Oil agglomeration process development unit (100 kg/hr); Fischer Tropsch process development unit (5 litres/day); Coal fertilizer plant (20 kg/day); Coal oil stabilized slurry PDU (100 kg/batch); Sponge iron plant (8 kg/hr); and Fluid-bed gasifier (30 kg/hr).

For conducting physical and chemical survey of Indian coals and lignite before and after mining, CFRI has seven regional coal survey laboratories located in the major coal bearing areas of the country.

Special research and testing equipment available at CFRI include: several types of chromatographs including HPLC, infrared spectrograph, mass spectrometer, electron microscope, X-ray diffraction unit, NMR spectrometer, UV-VIS spectrophotometer, atomic absorption spectrophotometer, microscope photometer, NQR spectrometer, Leitz heating microscope, derivatograph, slag viscometer, thermogravimetric balance, Gieseler's plastometer, C-14 tracer equipment, Mössbauer spectrograph, automatic surface area analyzer, FT NMR spectrometer, Parr Model 1241 adiabatic oxygen bomb calorimeter, 1 lit. magnadrive autoclave, microprocessor controlled digital integrator with printer-plotter, ESR spectrometer, gamma chamber, Leco-Mac 400 proximate analyzer, thermal analyzer 150 kg/hr cap. ball mills, Action station-16, personal computer IBM-PC/XT

type, microtrace particle size analyzer, flue gas analyzer with strip-chart recorder.

The R&D activities of CFRI have resulted in a number of processes which are under utilization. These relate to: active carbon from coal/lignite/coconut shell, anthracene purification, anthracene to anthraquinone, naphthol, cresol and resorcinol, briquettes from low grade coal, carbion, fly ash bricks, cyanopyridines, improved beehive oven design, lump coal devolatilizer, pelletization, weather resistant briquetted industrial fuel and Lisasorb, weather resistant smokeless briquette for domestic or industrial purpose; development of a new design beehive coke oven.

The following R&D projects (area-wise) of CFRI have reached the pilot plant/PDU scale experimentation stage: (1) Coal beneficiation/coking coal conservation: demineralization of coal by oil agglomeration technique and by chemical means, beneficiation by oleoflotation technique, formed coke preparation from non coking coals for industrial and metallurgical uses, direct reduction process using iron ore-coal agglomerates, and selection of coking blends for the existing and proposed steel plant; (2) Replacement of oil by coal/coal derived fuels: production of stabilized coal-oil slurry (CARBOIL) for combustion, preparation of non-settling pumpable concentrated coal-water slurry feed for direct combustion, hydrogenation of coal pilot plant studies, Fischer Tropsch process development studies, two-stage fluid-bed gasifier for production of fuel gas from undersize low grade coal, development studies on 75 kg coal per hour fluid-bed combustor-cum-air-heater, and inert gas generators for combating mine fire (capacity 500 m^3/hr each); (3) Chemicals from coal/coal tar: production of coal fertilizer (coal-acids) process development unit, and synthesis/production of various chemicals from coal carbonization byproducts; and (4) Domestic fuel: smokeless domestic fuel from fine coal/weathered coal/low grade coal. In addition to these, there are a number of basic inhouse projects in the area of resource quality assessment, coal chemistry, catalysis and adsorbents, chemicals and products from coal besides synthetic gas generator for FT, PDU, etc.

The institute publishes three periodicals, viz. *Fuel Science & Technology* (quarterly); *CFRI Newsletter* (bimonthly) and *CFRI Samvad* (bimonthly—Hindi).

SURVEY LABORATORIES

1. CFRI Coal Survey Laboratory
   Jharia
   P.O. FRI, Dhanbad (Bihar)
   Telegram: RESEARCH, FRI
   Telephones: 61699, 61807 & 61853

2. CFRI Coal Survey Laboratory
   P.O. Namkum
   Ranchi (Bihar)
   Telegram: COALSURV
   Telephone: 20348

3. CFRI Coal Survey Laboratory
   17/C Telenkhedi-Area
   Civillines
   Nagpur
   Telegram: COALSURV
   Telephone: 31319

4. CFRI Coal Survey Laboratory
   Canal Roal
   Jammu-Tawi (J&K)
   Telegram: COALSURV
   Telephone: 5912

5. CFRI Coal Survey Laboratory
   P.O. Raniganj, Burdwan (W.B.)
   Telegram: COALSURV
   Telephone: 95

6. CFRI Coal Survey Laboratory
   Jorhat (Assam)
   Telegram: COALSURV
   Telephone: 185

7. CFRI Coal Survey Laboratory
   Circuit House Road
   Bilaspur (M.P.)
   Telegram: COALSURV
   Telephone: 102

CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE (CGCRI)

P.O. Jadavpur University, Calcutta 700032
(Estd 1950)

Telegram: GLASCERCH

Telephones . 463496 & 465829
Telex: Glserch Ca: 7560

Director: Dr B. K. Sarkar, Ph.D. (Materials Science) (London University)

The objective of the institute is scientific and industrial/applied research of national importance in the field of glass, ceramics, refractories, various enamels and composites. The activities of the institute are concerned with: (1) Development of technologies relevant to the country's social, defence, economic and industrial needs; (2) Evaluation and optimum utilization of the country's resources of related raw materials; (3) Attainment of technological competence and self reliance in the field of special glass and ceramic materials; (4) Absorption, adaptation and updating of imported technologies relevant to the country's social, economic and industrial needs in the related fields; (5) Carrying out projects sponsored by public/private enterprises and rendering technical assistance to industry in improving quality, productivity, design and performance of furnaces, etc.; (6) Basic research in related fields necessary for furthering applied research and for building up scientific and technological capability; (7) Rendering technical advisory services like information, consultancy, testing, etc. to industry and government departments in developing glass and ceramic industries. Attempts are made to meet the requirements of the rural sector and cottage scale industries, with special emphasis on using the traditional skills and capabilities and with a view to generating employment particularly for the weaker section of the society.

The work of the institute is carried out in the following divisions: Science and technology of glasses; Clays, whitewares & technical ceramics; Refractories; Ceramic metal systems; Composites; High temperature materials and tracer techniques; Crystal growth and communication fibre; Electro-ceramics; Furnaces and fuels; Analytical chemistry; Optical glass pilot plant & workshop; Design and engineering

(including project engineering and instrumentation); Scientific information and publication (including library, documentation, publication/publicity, technology utilization, data bank and computer cell); PME cell, and two extension centres—one at Naroda (Gujarat) and the other at Khurja (U.P.).

Special attention is paid to research programmes concerned with development of products of strategic and critical importance from indigenous raw materials and of substitutes for imported items. The institute's pilot plant for optical glass which went into production in 1961 supplies optical glass to Defence establishments and optical instruments industry. It has so far supplied over Rs 200 lakh worth of optical glass which, otherwise, would have to be imported. Its quality is comparable to that of the best optical glass produced anywhere in the world. Bharat Opthalmic Glass Ltd. Durgapur (a Government of India undertaking) is commercially producing optical glass and tank periscope prisms, etc. based on the institute's process. Superconductivity work in collaboration with three other national laboratories and Defence oriented projects are underway for the development of new types of optical glasses and filters and laser glasses of various types. High temperature protective enamels for turbo-jet aeroengine components developed in this institute are already under production by Defence.

Other CGCRI processes/products under utilization include: Rice husk insulating bricks (phosphate bonded and chemical bonded); Sodium silicate from rice husk ash; Glass reinforced gypsum; Water filter candle; Mica based textured coating; Ceramic colours; Glass colours/enamels; Alumina ceramics for electrical, electronic and other engineering uses; Cordierite saggar; Lowcost technology for fibre glass; Glass electrodes for pH, pNa and pK measurements; Blood capillary pH electrodes and pCO_2 electrodes for anaesthesia monitoring equipment; Bloating type refractories for casting pits of steel plants; High strength plaster of Paris; Lead free white and coloured enamels for aluminium metals; Lead free enamels for wire wound resistors; Reaction bonded silicon nitride; Glazed wall tiles from common clay; Inorganic bonded micanite; Mica insulating bricks; Glass bonded mica products; Regeneration of plaster of Paris; Decolouration of mineral substances such as clays and sand; Thermal conduc-

tivity tester; High alumina cement; High alumina aggregate; Matt glazed tiles; Sol-gel application of anti-glare coatings on sheet glass; Glass ceramic coating compositions for mild steel and stainless steel; Low thermal mass kiln; Staining composition of glass; Glass ceramic tiles for abrasion and corrosion resistant applications; High temperature protective enamels for jet aero-engine components; High alumina bricks from sillimanite beach sand and High density dolomite sinters.

An integrated multidisciplinary project of the institute is aimed at conservation of fuel in firing of ceramic products, reducing environmental pollution, etc. The project covers: introduction of low thermal mass furnaces with considerably higher fuel efficiency in place of conventional kilns; development of low energy refractories from agrowastes, etc.

Another thrust area is concerned with the development of components for communication systems and electronic industries. This includes: Production of optical glass fibres for optical communication system; development of synthetic quartz single crystals and development of thick film printing ink/paste for electronic industries.

Another major area of research is the development of special materials which include: Non-oxide refractories, such as silicon nitride and silicon carbide; crystal glasses and oxide ceramic for engineering applications; high purity fused silica, newer types of optical glasses; multilayer ceramics, high-tech ceramics, refractories for non-ferrous industries. A continuing programme of work of the institute in collaboration with other agencies, is the systematic evaluation and beneficiation of such raw materials as glass, sands, quartz, quartzites, limestones, clays and kyanites so as to help the industry utilize them.

Facilities are available at the institute for testing of glass and ceramic raw materials and products. Consultancy services are rendered on evaluation and beneficiation of glass and ceramic raw materials. The institute publishes: *Central Glass and Ceramic Research Institute Bulletin* (quarterly), *Documentation List on Glass and Ceramic* (monthly) and CGCRI annual reports.

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CENTRAL INSTITUTE OF MEDICINAL AND AROMATIC PLANTS (CIMAP)

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(Estd 1959)

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Telephones : 71170, 71568,
74136, 74137
PABX : 74043, 73654, 74520
Telex : 0535-298

Director : Dr R. S. Thakur, M.Sc., Ph.D., F.R.S.C., F.I.C., F.N.A.Sc.

The institute undertakes R&D/promotional work related to introduction, cultivation, production, processing, utilization and marketing of medicinal and aromatic plants, with specific reference to their practical application and utility. The institute has well-equipped laboratories and a research farm, a pilot plant and four glass houses located near Kukrail forest, on a 21 ha plot.

The work of the laboratory is carried in three major divisions : (1) Chemical Sciences covering essential oil chemisty, medicinal plant chemistry and instrumentation, chemical engineering and analytical chemistry; (2) Agricultural and Biological Sciences covering botany and pharmacognosy, agronomy and soil science, genetics and plant breeding, plant pathology, entomology and plant physiology, biochemistry and plant tissue culture; and (3) Information, Liaison and Extension covering medicinal and aromatic plants information service, extension and liaison, planning and monitoring, herbarium and museum, library and art and photography.

The institute has regional centres/farms at : (1) Bangalore with office at National Aeronautical Laboratory (NAL) and farms at Belur (10 ha), NAL (28 ha), Kodimanchenhally (12.5 ha) and Coorg (Mysore) (101 ha); (2) Pantnagar (U.P.) (104.5 ha); (3) Srinagar, with farms at Bonera and Yarikha; (4) Kodaikanal (Tamilnadu) (40 ha); (5) Tung (Darjeeling); and (6) Boduppal (Hyderabad) (12 ha).

Development of agrotechnologies for the cultivation of medicinal and aromatic plants, both indigenous and exotic, in demand in the country is an important programme of work of the institute. The CIMAP developed agrotechnologies which are under utilization relate to : (1) Japanese mint (*Mentha*

arvensis Linn. subsp. *haplocalyx* Briquet var. *piperascens* Holmes), (2) Peppermint (*Mentha piperita* L. var. *officinalis* Sole. subvar. *rubescens*), (3) Bergamot mint (*Mentha citrata* Ehrh.), (4) Native spearmint (*Mentha spicata*), (5) Scotch spearmint (*Mentha cardiaca*), (6) Citronella Java (*Cymbopogon winterianus* Jowitt), (7) Palmarosa (*Cymbopogon martinii* Stapf. var. *motia*), (8) Linaloe (*Bursera delpechiana* Poiss.), (9) Geranium (*Pelargonium graveolens* L. Herit.), (10) Davana (*Artemisia pallens* Wall.), (11) French basil (*Ocimum basilicum* Linn.), (12) Patchouli (*Pogostemon patchouli* Hook.), (13) Hops (*Humulus lupulus* Linn.), (14) Bulgarian coriander (*Coriandrum sativum* Linn.), (15) Ergot [*Claviceps purpurea* (Fr.) Tulasne], (16) Belladonna (*Atropa belladonna* Linn.), (17) Pyrethrum (*Chrysanthemum cinerariaefolium* Vis.), (18) *Ammi majus* Linn., (19) Periwinkle [*Catharanthus roseus* (L.) G. Don], (20) *Eucalyptus citriodora* Hook., (21) *Rauvolfia serpentina* Benth. ex Kurz., (22) Lemongrass [*Cymbopogon flexuosus* (Steud.) Wat.], (23) Lavender (*Lavandula officinalis* Chaix), (24) *Duboisia myoporoides* R. Brown, (25) *Hyoscyamus muticus* L., and (26) Opium poppy (*Papaver somniferum* L.).

The development of process technologies for obtaining end products of the aromatic and medicinal plants is another major activity of the institute. The CIMAP technologies relating to the production of (1) diosgenin from rhizomes of *Dioscorea deltoidea*, (2) menthol from *Mentha arvensis* oil, (3) hyoscine and hyoscyamine from *Duboisia* sp., (4) rose oil from *Rosa damascena*, (5) vetiver oil, (6) *Cyperus scariosus* oil and (7) pyrethrum oleoresin from pyrethrum flowers, are under utilization.

Some of the recent significant achievements of the institute relate to : (1) release of two varieties of opium poppy yielding 25-50% more latex (opium) than local cultivars, (2) commercial cultivation of newly evolved high-yielding Japanese mint strain (CIMAP/MAS-I and CIMAP/HYBRID-77) on the farmers' field, (3) development of a new promising clone of lemongrass (CIMAP/L.S.-48) giving higher yield than the existing strain, (4) development of superior clones of Java citronella, and (5) development of high yielding varieties of palmarosa.

CIMAP has successfully introduced exotic variety of rose (Bulgarian rose) and pilot scale plantation established in Kashmir valley. About 3 kg of Bulgarian rose oil valued at about

three lakhs of rupees was produced during 1986-87. The yield of flowers as well as oil was more than that obtained in Bulgaria. Introduction of Chinese antimalarial drug plant, *Artemisia annua* and development of processing technology for production of artemisinin from it is another spectacular success story of CIMAP in the recent past.

The institute has already established a basic science division which deals with basic genetics and plant breeding, plant physiology, biochemistry, tissue culture and genetic engineering. It would help in obtaining such new genotypes/strains which would not only give higher yield of biomass, but would also have several fold active constituents and the lines resistant to diseases and pests.

Efforts have also been made to strengthen the existing regional centres of the institute, with a view to making them a model for rural development and the basis for setting up of a large number of mini and cottage industries based on the cultivation of medicinal and aromatic plants in the respective regions.

Modern facilities for physical and chemical evaluation of essential oils and crude drugs are available. The instrumentation facilities include : atomic absorption spectrophotometer (SP 2900 Pye Unicam), infrared spectrophotometer (3998 Perkin-Elmer), ultraviolet spectrophotometer (SP8-100 Pye Unicam), UV-VIS specord (Carl Zeiss, Jena), digital polarimeter (DIP-181 Jasco), gas chromatograph (3920B Perkin-Elmer), HPLC analytical system (Waters Associates), droplet counter current chromatograph (DCC-A) and liquid scintillation counter [LKB 1215 (Rack beta II) Wallac], balance mettlers (H51 AR and PL 1200) and a Hewlett-Packard 3390A integrator. A transmission electron microscope with scanning attachment (420-T Philips), FT-NMR and GC-Mass spectrometer have also been installed for advanced research.

The institute brings out : *CIMAP Newsletter* (quarterly), *Current Research on Medicinal and Aromatic Plants* (quarterly), and its annual reports, apart from farm bulletins on economically viable medicinal and aromatic plants.

REGIONAL CENTRES

1. CIMAP Regional Centre
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3. CIMAP Regional Centre
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Srinagar 190005 (J&K)

4. CIMAP Regional Centre
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5. CIMAP Regional Centre, Tung
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6. CIMAP Demonstration Farm
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CENTRAL LEATHER RESEARCH INSTITUTE (CLRI)

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(Estd 1953)

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Director: Dr R.B. Mitra, M.Sc., Ph.D.

The main functions of the institute are: (1) To carry out R&D work on leather, leather auxiliaries, leather goods, leather-based articles and footwear; (2) To carry out fundamental and applied research on hides and skins, collagen, tanning agents and tannages, polymers, finishing materials, effluent treatment and slaughter house byproducts; and (3) To transfer technology developed in the field of leather science to the industry through the Base Unit and RCEDs to meet the needs of rural, medium and large sectors of the industry and provide training in leather technology and leather goods.

Of late, CLRI has adopted a modernization programme particularly in the thrust areas of chemicals, footwear and auxiliaries and in the tannery processes. Accordingly, the institute has restructured the R&D activities to CSIR mission projects, Thrust area projects and Laboratory projects. The R&D activities are categorized into five divisions: (1) Biological Sciences including collagen, biophysics, biotechnology and bioproducts; (2) Chemical Sciences including organic chemistry, physical and inorganic chemistry, chemical physics and polymers; (3) Engineering Sciences and Technology covering leather process technology, leather products technology, chemical engineering and environmental technology; (4) Information Sciences covering economic research, National Information Centre for Leather and Allied Industries (NICLAI), planning and technology transfer and leather science centre; and (5) Education and Training covering education for degree courses, training and development activities, research for industrial trainees.

Infrastructural facilities at the institute include: (1) Computer Aided Design Centre established at a cost of Rs four million for the development of footwear designs for the benefit of the industry to enable them to become a trend setter for the rest of the world. The facility will be extended for the development of designs for garments and various other

leather goods; (2) Footwear pilot plant with a capacity of producing 500 pairs of footwear per day. This is expected to serve CLRI in developing skills towards designing and fabrication of footwear and also for the training of technocrats and engineers in this specialized area; (3) Modernized chemical process pilot plant with chemical process equipment for the various unit operations and processes. The facility has been created for scaling up of processes/products developed by CLRI to semi-commercial/pilot plant scale. Pilot plant facilities are also available for animal waste byproducts for maximizing returns by better carcass utilization; (4) Design cell for preparation of basic design packages for tanneries and chemical process plants; (5) Cell for Safety and Risk Analysis to cater to the safety needs of leather and chemical process industry.

Through the normal tannery and scaling up facilities available at the institute, new technologies are developed to meet the needs of different sectors of Indian leather industry. Refresher training programmes are organized for technical personnel with a view to improving their expertise and skills. With increased emphasis placed by the government on the manufacture of finished leather and leather articles, the institute has been helping the industry in preparing project reports, schemes and layouts either for setting up new units or for diversification.

The institute, in collaboration with the Anna University, conducts B.Tech and M.Tech courses in Leather Technology and Footwear Science and Engineering. Also, CLRI is a recognized centre for doctoral research. The post-graduate programmes in footwear science and engineering are the first of their kind in the world.

CLRI is an internationally recognized centre for training in leather technology and leather products manufacture NICLAI has been functioning in CLRI for nearly 10 years. The Data Bank serves as a multifaceted information retrieval system and handles a variety of data generated by CLRI. The CLRI library has been completely reorganized and redesigned. Also a Patent Information Centre is functioning at CLRI library.

The research activities in the institute are carried out after thorough project planning, budgeting monitoring and evaluation. The institute collaborates with other institutions and

industrial units in research development and design activities. The facilities are made available to the industry and other organizations at reasonable fees for physical and chemical analyses and job works.

The finishing auxiliaries developed at the institute include soft binders, impregnants, fillers and adhesives based on acrylic compositions, top coats based on nitrocellulose and polyurethane, aqueous pigments and protein binders. Adhesives and synthetic foundation materials based on polyurethane have been developed for leather footwear.

The following technologies which were assigned to NRDC have been released: Acryl soft binder, Casprol 'T', Syntan pur, and Sulphated oil fatliquor.

The institute has set up a model effluent plant in a tannery at Ranipet and extends expertise and assistance to the tanners in setting up plants, on specific request.

Basic studies conducted by CLRI relate to structural aspects of collagen from the fibregenesis level to tanning, preservation and tanning through the aid of novel and conventional agents, application of polymer and polymer composites in biomedical needs and bioaccumulation of toxic substances in tannery effluents.

The institute undertakes the design and development of machines, instruments and equipment required in leather research and leather making.

The institute publishes the following periodicals: *Current Leather Literature* (monthly abstracting service), *Trends in Leather World and Manufacturers Corner* (monthly industry information service), *Leather Science* (monthly), *Thol Vignanam* (Tamil quarterly), *Charma Vigyan* (Hindi quarterly), *Rahber-e-Chirm* (Urdu quarterly), *Charma Vidnyan* (Marathi quarterly), *Leatherlars* (SDI) and *Leather Digest*.

Apart from training graduates and post-graduates in leather chemistry and technology, CLRI is engaged in formulating standards for ISI for leather and allied chemicals.

Certification of finished leather is done at CLRI and its Regional Centres for the Department of Customs.

Testing facilities are available for chemicals/leather auxilliaries and physical and chemical analysis of leathers.

FIELD STATIONS

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   Telephone: 474575
3. Regional Centre for Extension and Development (CLRI)
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   Telephone: 4711
4. Regional Centre for Extension and Development (CLRI)
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   Telephone: 87138
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CENTRAL MECHANICAL ENGINEERING RESEARCH INSTITUTE (CMERI)

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Telex: 0205-213

Director: Dr A. Gopalakrishnan, B.Sc. (Engg), M.S., Ph.D. (California), F.I.E.

The R&D work of the institute is organized in the disciplines of Applied mechanics, Applied science, Automobile engineering, Heat power and refrigeration, Material science, Production engineering, Product development and Industrial design. The institute assists the industry through research, design and development, consultancy, feasibility study and developmental testing with a view to evolving new products and processes leading to import substitution and export promotion, and for quality control of products and materials, for higher productivity, cost reduction, waste recovery and utilization. Assistance to the industry is also provided through training programmes, seminars, symposia, publications and documentation in specific areas of science and technology. As the premier organization in the field, the institute has built up centres of excellence in high technology areas with the right type of infrastructure and expertise to meet the challenges posed by the changing needs of the country's growing industries.

In view of the current needs of the country, the institute's immediate goals are: (1) Development of machinery, equipment and sub-systems which can be commercialized within the country for use in the industrial, agricultural, transportation, food processing and other relevant sectors; (2) Development of a centralized national capability in the field of design and reliability engineering and safety evaluation of engineering products; (3) Establishment of adequate infrastructure and expertise in the emerging frontier areas of inter-disciplinary mechanical engineering sciences so that further indigenous development can proceed close to the international level; (4) Participation in National Technology Mission and Societal Mission for the benefit of a large segment of the underprivileged population; and (5) Providing sophis-

ticated mechanical and allied engineering developmental inputs to national agencies like the Defence Research and Development Organisation (DRDO), Steel Authority of India Limited (SAIL), Department of Ocean Development, Department of Non-Conventional Energy Sources, Department of Atomic Energy, Indian Railways, etc.

The R&D work of the institute and its regional centres is classified under five broad categories: collaborative research, sponsored research, technical consultancy, technical services and in-house programmes.

The institute has developed in the past a large number of machinery and equipment which have led to import substitution, export promotion and higher productivity. Important projects handled in industrial and other heavy machinery relate to high speed paper lapping machine, high speed twinning machine, automatic turret lathe, multi-spindle reaming machine, LPG domestic stove, brick moulding machine, tribotester, two-needle five thread safety stitch, high speed over-lock machine, coil expanding and spreading machine, digital maximum demand indicator, etc.

In the field of farm and food processing machinery, various agencies have acquired CMERI know-how for 20 hp Swaraj tractor, pedal pump, paddy husk combustor for drying paddy, dual purpose rotillor, rice polisher, combine harvester, deep well hand pump, canned fruit processing cooker, palmirah neera evaporator, etc.

To aid small industries, CMERI has developed machinery and equipment which include electro-chemical marking machine, wool knitting machine, tyre retreading machine, crack depth gauge, pencil type coating thickness gauge, dye penetrants; wool carding machine and road paint marking machine.

The current projects in progress relate to condition monitoring of power plant, design and development of dust extraction plant, micro-hydroturbine paddy transplanter, computer aided design, large volume plasma system, mechanical handling and processing of city garbage, high speed air bearing, robotics application in steel structural shop of profile cutting by oxy-acetylene flame torch on MS plates, design and development of sub-surface sampler, prototype fabrication of coir tufting machine, design and development of coir pitch briquetting machine, etc.

Other projects under progress include combustion system of coal oil mixture, fluidized bed gasification of coal, automatic cementing and folding machine, design and development of lime-kiln and design and development of fly ash sintering plant.

Providing technical consultancy is an important function of the institute. Consultancies offered in recent years relate to investigation into factors affecting performance of cold storage, failure investigation of traction motor cooling blower for electric locomotives, design and development of gas removal system for LPG bottling plant at Kalyani, setting up of test rig and performance evaluation of nozzles for irrigation sprinklers, optimization and transportation of waxy crude oil through submarine pipe line, development of appropriate technology for modernization of cottage industry on sabai grass processing in Orissa, etc.

Excellent facilities supported by sophisticated equipment and highly qualified and experienced scientists are available for testing and evaluation of engineering products and materials. Demand of the service for destructive and non-destructive testing, vibration and noise analysis, filter testing, chemical and metallurgical analysis, etc is in the increasing order.

To meet the shopfloor needs of the industries, the institute has five regional centres designated as Mechanical Engineering Research and Development Organisations, at Durgapur (exclusively for welding technology), Madras, Pune, Ludhiana and Cochin. Training in specialized fields is also imparted as and when called for by external agencies. Seminars and symposia are organized periodically.

A Liaison Office functions at Calcutta.

REGIONAL CENTRES

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Telephone: 412179

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CENTRAL MINING RESEARCH STATION (CMRS)

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(Estd 1956)

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Director: Prof. B. Singh, Ph.D. (Durham), M. Engg. (Sheffield), B. Engg. (Hons) (Min.) (Sheffield), B.Sc., F.I.E., M.M.G.I., C. Engg., F.C.C.M.

The laboratory has been engaged in applied and basic research in the field of mining and allied industries to increase production of minerals, safety of mines and miners, and efficiency and economy in mining operations; to reduce health hazards to mine workers; and to conserve mineral resources of the country.

The areas of mining sciences that have engaged the laboratory's increasing attention and where significant expertise has already been developed to make its mark felt on Indian mining scene are: (1) Rock mechanics and mining methods; (2) Safety and environment in mines; (3) Mine engineering design and development; and (4) R&D infrastructure.

Through its R&D activities and consultancy services the laboratory has assisted the Indian mining industry for almost three decades in assimilating and adapting new and modern technologies with more safety in mines and miners as well as reduced health hazards. Also, in the field of rock mechanics and ground control, it has established itself as a centre for advanced rock mechanics and ground control research with mathematical modelling.

Improved mining methods basically to control the ground movements and conserve coal, e.g. wide-stall, narrow panel and barrier, and heightening and widening of galleries, have been successfully experimented at collieries at Moonidih, Salanpur, West Jhagrakhand and other places.

'Equivalent material mine modelling' technique has been developed and used to predict various parameters of methods of extraction of coal seams. Over 40 models have been made and half a dozen new or modified methods of extraction have been suggested to the industry. Some are under field trials.

Based on investigations in 75 panels, CMRS has developed new methods of determining optimum support system

in longwall workings. The method has been proved superior to foreign methods. Thirty longwall faces have been planned on the basis of these norms at the request of the industry. A book on the subject has been published.

CMRS has developed improved support system for mechanized depillaring in coal mines, to reduce drudgery of shoulder loading of baskets by miners, leading to improvement in productivity by 50 to 100%. The know-how is being introduced in other coalfields on a large scale (DGK 9 inline, SCCL; Govinda colliery, SECL and PK-1 Mine, Pathakhera, WCL).

On the basis of mine subsidence investigations conducted over 100 panels, 81 sponsored problems of industry have been studied to conserve 7 million tonnes of coal. Adra-Gomoh main railway line has been made to subside by a maximum of 600 mm on the advice of CMRS without disrupting its operation during the past 16 years.

A new criterion for design of mine pillars for partial extraction below surface properties has been evolved. This has been checked against 43 cases. Optimum size of pillars has been determined in 100 cases. These studies have helped conserve 6.5 million tonnes of coal.

Hydro-pneumatic system of stabilization of unapproachable mine workings below surface properties has been developed and successfully demonstrated at two mine sites. This is expected to protect surface properties and people in Raniganj, Barakar, Kulti, Jamuria and many other townships in coalfields. A scientific investigation at Ramjeebanpur colliery is in progress in collaboration with ECL, CMPDI & ADDA.

Improved designs of hydraulic sand stowing plants have been provided to 50 coal and metalliferous mines for filling at rates up to 650 tonnes/hr and with concentration up to 75% of solids by weight. Improvements up to the extent of 10 times the existing rates have been achieved resulting in greater safety, production and productivity.

Design and development of supporting systems involving use of rope stitching, rock bolting, screw prop, triangular chock, pit prop, etc. have helped conserve and improve safety productivity and economy. These are in use in over 200 mines. These supports are being manufactured by over 100 manufacturers.

To improve safety and economy in open pit mining operations, slope stability and geo-mechanical investigations have been conducted in 22 mines to help extract about 5 million tonnes of minerals.

Design and application of controlled blasting techniques by CMRS in over 80 projects have enabled mine managements to conduct blasting operations with better safety and economy. These have reduced vibration effect and helped extract minerals within 30 m from structures. It has helped to extract coal from fire areas and enabled hydroelectric projects to continue with excavation and construction work simultaneously within 3 m and to obtain a neat and clean final excavation surface free from over and under breaks.

A new technique of *in situ* bacterial degasification of coal seam has been developed to reduce explosion hazards in mines. The technique has been successfully applied in nine mine locations, leading to over 50% reduction in methane emission rate and thereby faster rates of development and extraction.

Rock mechanics studies in non-coal mines have helped in improving conservation, safety and productivity. The studies have led to: (i) Improvement of room and pillar design in three copper mines; (ii) Extraction of lead and zinc ore by sub-level open stoping method up to 100 m height and extraction of ore locked up in remnant pillars (Zawar mines); (iii) Design and successful implementation of new mining method in a phosphate mine (Maldeota); (iv) Introduction of improved ground reinforcement techniques in 15 mines; and (v) Design and experimentation of concrete matting in a mica mine.

Based on systematic geomechanical studies in 17 hydroelectric and irrigation tunnels throughout the country including those located in the Himalayas, a number of new approaches have been evolved for selecting proper tunnel alignments and optimizing support requirements.

CMRS advice has helped National Thermal Power Corporation (NTPC) save two crore rupees in cost of construction of tunnel at Rihand thermal power project in Mirzapur District of U.P. by avoiding reinforcement in lining as recommended by two foreign consultants.

CMRS has helped more than 100 mines to reorganize, plan and improve their ventilation systems. Computer based

analysis of ventilation systems is now being used This has helped in improving working conditions underground CMRS has utilized pressure balancing technique for quenching mine fire in Madhujore colliery of ECL and the mine is producing coal since then, otherwise the mine had to be closed The technique has been used for the first time in the country.

Air pollution by particulate matter, i e dust, was studied by CMRS in 70 mines In many cases it resulted in improved environmental conditions and enhancement of production and productivity by reducing dust concentration.

To create an awareness of health hazards of environment pollution, large scale surveys of air, water, noise, nutritional intake, lung function and other studies have been conducted in coal mining areas in Jharia and Raniganj coalfields and in steel, cement, fertilizer and other plants In the later cases precautionary measures have improved environmental conditions Over 15,000 miners were surveyed for pneumoconiosis, establishing gravity of the situation in Indian coal mines On the basis of this information, the industry has initiated preventive measures.

Eighteen fires in coal mines, one in a pyrite mine, two in coal washeries and one in an underground cinder heap below the floor of a big workshop and store have been successfully dealt with Methods of dealing with fires using silicic acid gel infusion and inert gas infusion have been successfully applied in seven cases Two types of sealants have been developed and tried in collieries to prevent leakage of air in mine workings and thereby preventing fires. A high expansion foam has also been developed for creating a foam plug against underground fires which would be useful for fighting mine fires.

CMRS has developed over 90 devices to promote safety in mines which are being manufactured by over 150 companies. The hydraulic prop manufactured by an entrepreneur based on CMRS know-how, is being exported abroad To improve communication in mines a system has been developed which is being used in 70 mines. In two cases lives were saved because of this system The laboratory has also helped Indianize steel wire-rope, explosives, flame-proof and intrinsically safe equipment and other safety equipment manufacturing industry by providing back-up facilities This

has saved crores of rupees in foreign exchange.

CMRS organizes training programmes, seminars, symposia and short courses (sponsorship basis) on mining and allied industries for their benefit. Foreign collaboration programmes are also negotiated by CMRS itself for co-operative research with other countries.

The laboratory publishes: its annual reports, *CMRS Review* (annually), *CMRS Bulletin* (bi-monthly), *CMRS Service to Industry* (quarterly), *Important Achievements of CMRS* (annually), and *Kendriya Khanan Anusandhan ki Mahatvapurna Uplabhdiyan* (annually). Besides these regular publications, status reports and S&T project reports are published. CMRS has already published status reports on Subsidence, Environmental Engineering, Mine Water, and Rock Mechanics. CMRS is fully equipped and has developed the infrastructure for taking consultancy work.

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CENTRAL ROAD RESEARCH INSTITUTE (CRRI)

P.O. CRRI, Delhi-Mathura Road, New Delhi 110020
(Estd 1952)

Telegram: ROADSEARCH Telephones: 6832173, 631959 & 631132
Telex: 3161369-CRRI IN

Director: Dr M P Dhir, B Sc Engg (Hons) MSCE (USA) Ph D FIE (India) MASCE (USA)

This institute is devoted to research on highway engineering in all its varied aspects, including road traffic engineering, transportation planning and road safety. Its objectives are: (1) To carry out basic and applied research, in line with the national priorities, for investigation, design, construction and maintenance of different types of roads and runways, including related materials such as aggregates and bitumen, with a view to effecting optimum economies; (2) To carry out research and development work on all aspects of road traffic and transportation engineering, including study of accidents, psychology of road users and transportation economics, and development of road safety devices, as related to different forms of transport; (3) To develop labour-intensive methods and manual aids for construction of lowcost, all weather village roads for alround economic development of rural and underdeveloped regions of the country; (4) To render technical advice and consultancy services to various organizations in the related fields to avoid import of foreign expertise; (5) To train road technologists through refresher courses/workshops and training programmes for the efficient implementation of road development plans in the country; (6) To create and establish all the necessary infrastructure, both in equipment and expertise, in the various facets of highway and transportation engineering and allied subjects, as and where need be, to achieve judicious solutions for special problems; (7) To develop and assist other institutions/departments in the scientific study of problems concerning roads, road transportation and related practices in particular regions; (8) Establishment, maintenance and management of extension units; (9) Demonstration and utilization of results of the researches; and (10) To enter into arrangements, with the approval of the Government of India, with foreign scientific agencies/institutions for exchange of scientists,

study tours, training in specialized areas of science and technology, conducting joint projects, and for providing technical assistance in the establishment of scientific institutions connected with all facets of roads and road transportation engineering.

The R&D activities of the institute are organized through its nine research divisions, viz. Geo-technical engineering. Soil stabilization & rural roads, Rigid pavements, Flexible pavements, Roads, Bridges, Traffic engineering and transportation planning, Environmental and road traffic safety and Instrumentation. In addition, sufficient infrastructure facilities concomitant to research exist, such as a specialized well stocked library, a mechanical workshop, a photographic reproduction unit, planning & monitoring unit and information and dissemination services.

The research projects of the institute have been drawn in consonance with national needs and imperatives and the user needs. Major fields of research input, currently, are geo-technical engineering problems concerning landslides; use of geotextiles in road pavement; ground improvement techniques for roads; appropriate technologies for rural roads; choice of bituminous binders and bituminous surfacings suiting different regions; alternative, modified and economic binders to cement and granular materials and construction; pavement surface characteristics and riding quality; development of pavement system for sandy terrains in desert areas, development of total transportation cost model for highways; deterioration and rehabilitation of bridge structure; traffic engineering and road safety; road transportation planning, etc.

The institute has got the facility of heavy loading frame for evaluating experimental road sections under static and repetitive loading and heavy duty pulsator for application of repetitive loading of different intensities and frequencies for testing of structures and the necessary reaction. Facilities are also available to determine the extent of susceptibility of road aggregates to polishing which determines the skidding characteristics of these materials when used in road construction. Facilities also exist to determine strength properties of concrete blocks by non-destructive testing. Besides, fully equipped laboratories are functioning to test bituminous materials. Facilities are available to accelerate weathering of bituminous mixes. Instron testing machine for fatigue testing, Benkelman

beam equipment with LVDT amplifier for measuring deflection and fourier transfer infrared spectrophotometer (FTIR) for characterization of road materials. To ensure the safety on roads and reduce the number of accidents and solve the environmental problems arising from the traffic, the institute has acquired an Act-React equipment (ART-90) from Austria.

Over the years, the institute has built up expertise and infrastructure to solve a wide variety of challenging highway engineering problems. The institute maintains a close liaison with organizations concerned with road planning and construction all over the country; the more important ones amongst these being the centre and the state public works departments, Ministry of Surface Transport, Municipal Corporations, Engineer-in-Chief's Branch of the Ministry of Defence and Border Roads Organization.

In the field of standardization, the institute has contributed towards preparation of many specifications, and has recommended practices and guidelines. It has been actively associated in standardizing a number of testing equipment and procedures, construction techniques and codes of practice for different types of roads through the Indian Roads Congress and Bureau of Indian Standards. In traffic and transportation, it has helped standardize traffic control devices, road signs, parking codes and other related guidelines.

Training is an important facet of the activity of CRRI, which aims not only at keeping the practising highway engineers abreast of the latest research developments but also at imparting practical training to them on the application of new improved techniques of highway and traffic enginnering. The institute conducts seven refresher/training courses every year for the nominees of user organizations. For junior field officers who generally do not attend these courses, on-the-spot field workshops are arranged in the different regions, in which the methodology involved in the implementation of different new improved techniques is demonstrated and training imparted.

The institute has many patented processes under commercial production. These include unevenness indicator, profilograph, automatic road unevenness recorder, reactive surkhi and lime reactive surkhi mixture, rotillor, fatigue testing machine, pavement paint marking machine.

The institute publishes annual reports, special reports and *CRRI Road Abstracts*.

CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE (CSMCRI)

Bhavnagar 364002
(Estd 1954)

Telegram: NAMAK

Telephones: 24496 & 24497
Telex: 0162-230 SALT IN

Director: Prof. M.M. Taqui Khan, M.Sc., Ph.D. (USA), C. Chem., F.R.I.C., F.N.A.Sc., F.A.Sc., F.N.A.

The primary objective of the institute is to carry out research and development work, both basic and applied, in the field of (1) Salt, and marine and other allied inorganic chemicals; (2) Desalination of brackish and sea waters; (3) Survey, cultivation and utilization of marine algae; and (4) Exploitation of coastal dune sand and saline soils by introduction and cultivation of indigenous and exotic plants of industrial value, and halophytes. The institute is actively participating in the Technology Mission on Drinking Water in Problem Villages.

The R&D activities of the institute are pursued by the following nine divisions: (1) Salt and marine chemicals, (2) Silicates and zeolites, (3) Reactive polymers (ion-exchange resins and membranes), (4) Reverse osmosis, (5) Marine algae, (6) Phyto-salinity, (7) Catalysis and coordination chemistry, (8) Planning and technical services, and (9) Public relations and publications.

The institute has two field stations one each at Mandapam and Berhampur. In addition to these, it has experimental sites at Okha, Zanjmer, Hatab and Nari (E.S.F.) which are being managed from Bhavnagar.

The institute has fabricated and operated pilot plants on bromine, reverse osmosis, electrodialysis, potassium fertilizers, refractory grade magnesia, etc. Presently, potassium chloride pilot plant is in operation.

The institute's R&D work has helped the salt and marine chemical industries as well as the industries based on algae and other plants as raw materials in improving the quality and yield of their products. In fact, the all India average yield of salt per unit area has considerably improved as a result of the R&D efforts of this institute. The requirement of salt of different grades particularly the industrial salt and dairy salt is now being fully met through indigenous production. The same can be

said with regard to the algal chemicals like agar-agar, and alginic acid and the industrially important silicates.

The institute's processes which are under commercial utilization include those for: free flowing table salt, cattle licks, bromine, magnesium trisilicate, calcium silicate, precipitated silica, agar-agar, sodium alginate, iodized salt, and elutriation-classification. The institute has also developed solar stills.

The major current research programmes of the institute are related to Solar salt works, Salt engineering, Membrane technology and Catalysis. The R&D work on solar salt works based on sea brine, well brines, lake brines, etc. is being carried out with a view to evolving a newer technology for complete utilization of brine. Under the salt engineering programme, work is continuing on the mechanization of various operations, development of equipment and machinery for washing and fortification of salt, and improvements in the traditional tools used by the salt industries. The work in the area of membrane technology relates to the development of new membrane monomers and polymers useful for direct desalination of sea water, treatment of effluent water involving different *p*H ranges and temperature, and treatment of organic systems. Simultaneously, development of technology for large scale desalination of brackish/sea water and design engineering studies on different reverse osmosis configurations are also being carried out. Studies are being made on the development of catalysis systems and process know-how for the conversion of syngas and other raw material into value-added organic chemicals. Synthesis of silicates and zeolites as support for catalyst is also being attempted.

The institute is participating in an international collaborative project titled 'Indo-USSR collaboration on solar energy utilization—development of solar autonomous power station based on sterling engine', and also in the all India coordinated project on introduction, evaluation, improvement, cultivation and biochemical investigations on guyule and jojoba. Projects on marine algal cultivation, resource assessment and utilization are also continuing.

The institute renders testing and analytical services on: (1) Salt; (2) Water and soil samples, brine, and potassic fertilizers; (3) Soda ash, sodium sulphate and other simple salts; (4) Limestone, magnesite, dolomite, magnesia, gypsum and simple minerals; and (5) Ion-exchange resin samples. Services are also of-

fered on china clay sieve analysis and particle size determination, and trace heavy metals determination in salt samples.

Facilities are available at the institute for: X-ray diffraction analysis, differential thermal analysis, surface area determination of powders (BET apparatus), gas chromatographic analysis of volatile substances, particle size determination by microscopic measurement, atomic absorption spectrophotometry, particle size distribution by sedigraph 5000 D, NMR spectroscopy, FTIR, etc. The institute publishes a quarterly news bulletin *CSMCRI News Letter.*

FIELD STATIONS

1. CSMCRI Marine Algal
   Research Station
   M.S. Bungalow, P.O. Mandapam
   Ramnad District
   Tamilnadu 623518
   Telegram: MARS MANDAPAM

2. CSMCRI Sea Water Irriculture
   Field Station
   House No. 20/3, Satya Niwas
   Hill Patna, Berhampur
   Ganjam District, Orissa 760005
   Telegram: SWI BERHAMUR

CENTRAL SCIENTIFIC INSTRUMENTS ORGANISATION (CSIO)

Sector 30, Chandigarh 160020
(Estd 1959)

Telegram: CENINSTS

Telephones: 31683, 25664
Telex: 0395-300 CSIO IN

Director: Dr S.R. Gowariker, M.Sc., Ph.D.

The laboratory is primarily engaged in research on and design and development of scientific instruments. The R&D activities of the laboratory span various disciplines like electronics, optics, medical electronics, applied physics, microelectronics, process control, environmental monitoring, surface analytical instrumentation, etc. The laboratory has designed and developed a large number of instruments in these areas and has passed on the know-how to the industries for commercial exploitation. These instruments are developed keeping in view the national needs as well as contemporary trends in technology and are fully engineered. The laboratory has substantially contributed towards the growth of indigenous scientific instruments industry and several new industries for the manufacture of precision instruments, and components have been set up with the know-how supplied by CSIO.

The research, design and development activities in the domain of electronic instrumentation and systems are mainly devoted to three major areas, viz. geophysical instrumentation, agri-electronic instrumentation and automatic test systems and measuring equipment for microelectronics like VLSI tester. Electronic instruments which have been designed and developed include digital multimeter, digital *p*H meter, digital data/information display system, furnace temperature controller, 50 MHz counter/timer, universal counter/timer (500 MHz), multi-point temperature indicator, digital grain moisture meter, digital salinity tester, multi-grain moisture meter, portable analog seismograph and microprocessor based digital cassette seismograph alongwith seismic playback system.

The laboratory has established a unique position for itself in the country in the field of medical instrumentation. It has developed technical know-how of a number of medical instruments viz. cardiac monitor, foetus stethoscope, echoencephaloscope,

X-ray image intensifier CCTV system, monitor dc defibrillator, minicardioscope, non-fade ECG monitoring system, cardiotocograph, vasec apparatus, automated biochemical analysis system, dialysis machine, digital colorimeter, etc. Important projects in progress include development of ultrasonic imaging systems and special equipment for primary health centres.

The research, design and development work in the broad area of optics is concerned with optical/electro-optical instruments like uv-visible spectrophotometer, specialized optical components and techniques, MTF test bench, white light holographic display techniques and fiber optics technology for short haul communication applications. Examples of optical instruments and components which have been developed are bubble chamber scanner, prismatic binocular, automatic slide projector, 75 mm refracting telescope, methane gas interferometer, infrared moisture analyzer, lenses for photocopying machines (different specifications), fresnel lenses, scanning lens system for electro-fax type of copying machine, 16 mm cine projection objective, projection attachment to Vicker's hardness tester, process/dark room camera objective, interchangeable 20X projection objective for bubble chamber scanner, masters for radial metrological gratings, thin film optical devices like interference filters and circularly variable neutral density filters, etc.

The laboratory has also undertaken design and development of analytical, mechanical, metallurgical, process and environmental pollution control instruments. Examples of such products/processes developed are water analysis kit, dissolved oxygen analyzer, digital tachometer, thermo-silico tester, ultrasonic hardness tester, electro-spot testing kits for ferrous and non-ferrous alloys, temperature indicating sticks, high strength copper base alloy (Cu—Ni—Sn), small scale production of spheroidal graphite iron in coke-fired crucible furnace, electromagnetic flowmeters (different diameters), digital turbidity meter, recording stack smoke opacity monitor, etc.

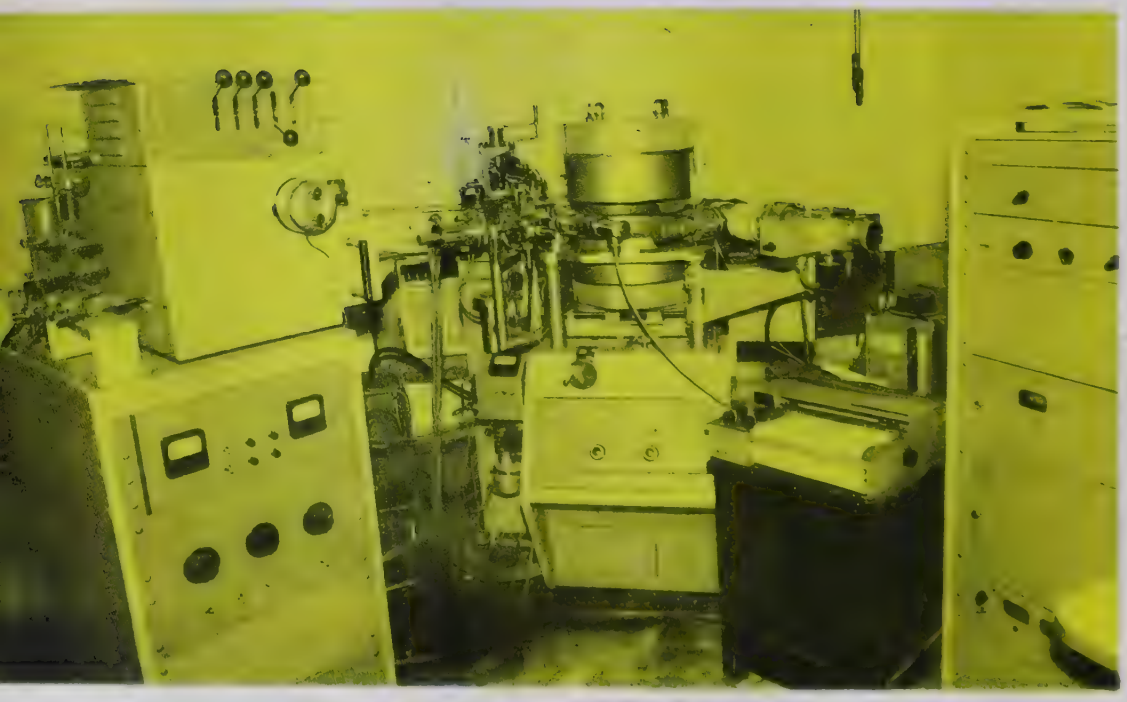
Work has also been pursued at CSIO for the development of combined electron spectroscopy for chemical analysis, Auger electron spectrometer, ion scattering spectrometer and work function measuring unit. Another sophisticated equipment under development is the X-ray lithography system.

The laboratory with its immensely vast and specialized experience has, during the past few years, concentrated its atten-

Microprocessor-based digital cassette seismograph alongwith seismic playback system : CSIO, Chandigarh

Automated biochemical analysis system : CSIO, Chandigarh

Fluorescence activated cell sorter at CCMB, Hyderabad



Mass spectrometer at IICB, Calcutta

Optical fibre telephone system introduced in one of the mines owned by TISCO : CMRS, Dhanbad

Salt iodization plant at Kichha village : CSMCRI process

Surface characteristics being measured by a profilograph : CRRI, New Delhi

Bullock cart with innovative design : CRRI, New Delhi

tion on the development of most sophisticated instruments in the following areas of national importance (1) Optics for space & defence applications; (2) Medical instrumentation covering linear accelerator for radiation therapy and hyperthermia system; and (3) Instrumentation for microelectronics.

An important activity of CSIO is to impart high grade technician level training in instrument technology through its Indo-Swiss Training Centre (ISTC) which was started in 1963 with the cooperation of Swiss Foundation for Technical Assistance. The ISTC conducts three-year Diploma Course in Instrument Technology, one-year Post-Diploma Course in Industrial Electronics and four-year Advanced Diploma Course in Die & Mould Making. The technicians trained in this Centre are in great demand in private and public sector industries and government institutions. Also, on-job training for varying durations is imparted by the laboratory to students from educational institutions and junior technologists from industrial and other organizations.

The laboratory has established a network of eight Service & Maintenance (S&M) Centres for providing specialized services for repair & maintenance of a large variety of instruments. These S&M Centres are located at New Delhi, Madras, Chandigarh, Bombay, Lucknow, Hyderabad, Cochin and Jaipur.

Sponsored projects are undertaken for the industries and government agencies in order to develop the know-how as per requirements of the user industry/government agency. The laboratory also renders advisory/engineering consultancy service in its field of specialization. In addition, the laboratory has been rendering technical assistance to outside agencies for a variety of jobs like fabrication of precision optical & mechanical components; testing, calibration & evaluation of instruments; metallurgical services, etc.

The laboratory brings out a quarterly journal *CSIO Communications* which publishes scientific papers, information about new instruments developed by CSIO and other organizations, etc. CSIO has brought out a prestigious publication entitled 'Directory of Scientific Instruments and Components Manufactured in India' which gives useful information about the Indian manufacturers of instruments and components.

SERVICE & MAINTENANCE CENTRES

1 Service & Maintenance Centre
(CSIO)
CSIR Complex 2nd Floor
NPL Campus Hillside Road
New Delhi 110012
Telephones 586794 585663

2 Service & Maintenance Centre
(CSIO)
CSIR Complex
Tharamani
Madras 600113
Telephone 412061

3 Service & Maintenance Centre
(CSIO)
Sector 30
Chandigarh 160020
Telephone 24614

4 Service & Maintenance Centre
(CSIO)
Sahakar Bhavan
Narayan Nagar
Ghatkopar
Bombay 400086
Telephone 5121994

5 Service & Maintenance Centre
(CSIO)
Lucknow Polytechnic Campus
Kanpur Road
Lucknow 226005
Telephone 51302

6 Service & Maintenance Centre
(CSIO)
Uppal Road
Habshiguda
Hyderabad 500007
Telephone 852952

7 Service & Maintenance Centre
(CSIO)
CSIR Centre Complex
Development Plot
South Kalamassery
Cochin 683502
Telephone 85-6551

8 Service & Maintenance Centre
(CSIO)
Plot No CSC 1
Malviya Industrial Area
Jaipur 302017
Telephone 75082

CENTRE FOR CELLULAR & MOLECULAR BIOLOGY (CCMB)

Hyderabad 500007
(Estd 1981)

Telegram BIOCENTRE Telephones 853487 & 850402
Telex: 0425-7046 CCMB IN

Director Dr P M Bhargava M S Ph D F N A F A Sc F N A Sc F N A Med Sc

CCMB, initially set up as a semi autonomous unit at Regional Research Laboratory, Hyderabad, in 1977, has been functioning as a full fledged national laboratory since 1981. The objectives of CCMB are: (1) To conduct research in frontier and multi-disciplinary areas of modern biology and to seek potential applications of this work. (2) To carry out exploratory work in areas of biology with a view to aiding the development of biochemical and biological technology in the country on a sound basis; (3) To train people in the advanced areas of modern biology to serve the needs of development in these areas, with special provision for short-term training of staff from other institutions in specialized techniques for which adequate facilities may not be generally available in the country. (4) To provide centralized facilities in the country for new and modern techniques in the interdisciplinary areas of modern biology, and to ensure that these facilities are so organized, maintained and administered that they can be put to maximal use by research workers from other laboratories and institutions in the country; (5) To interact adequately with other institutions (in India and abroad) doing basic or applied work in areas related to the activities of the Centre; and (6) To collect, collate and disseminate information relevant to modern biological research.

The Centre maintains liaison with several academic and professional organizations and institutions in India and abroad, particularly those concerned with areas of modern biology. As CCMB has been set up largely to carry out basic research in frontier areas of modern biology, different research groups are centred around individuals of proven competence and leadership; it has no conventional division or departments.

The current areas of research relate to: (1) Cell Division and Malignant Transformation: mechanism of regulation of cell division and malignant transformation; protein phosphorylation at tyrosine residues in normal cells; transformation by oncogenic viruses and the role of SV40-induced cellular protein, p53, in the transformation of mammalian cells; oncogenes and their function; cellular heterogeneity in the Zajdela ascitic hepatoma (ZAH); surface and membrane proteins of ZAH cells; DNA-binding protein(s) from Zajdela ascitic hepatoma cells; studies on the AK-5 tumour; heterogeneous behaviour of the AK-5 tumour cell line: differential expression of fibronectin in the tumour cells. (2) Development studies: cell lineages during mammalian embryonic development and cell differentiation; heat-shock proteins. (3) Structure and Conformation of Proteins and Nucleic Acids and their Interactions: conformation and the ion binding properties of cyclolinopeptide A; chemical synthesis and structural studies of deoxyribo and ribooligonucleotides; prediction of the structure of ribosomal ribonucleic acids; biochemical and histochemical localization of succinic dehydrogenase in the nuclei of lymphoid organs of rat. (4) Secretion and Transport of Proteins: studies on signal sequences; protein transport into nucleus. (5) Ribonucleases: a new type of ribonuclease from rat liver which behaves like a restriction ribonuclease; a high-molecular-weight ribonuclease from human milk; studies on ribonucleases from cobra venom; prediction of strong antigenic determinants of ribonuclease. (6) Protein Degradation: bovine seminal plasma protease 1 and hypersensitive peptide bonds. (7) Micelles and Membrane-Active Proteins: micelles—microenvironmental differences between micelles of different shapes and structures; studies on the status of hemin in aqueous solution and its interaction with membranes. (8) Evolution: studies on bacteria and yeast of Antarctica; antigenicity as a tool to study the evolution of proteins. (9) Study of Integrated Biological Systems: photoacoustic investigation of photosynthesis; spectroscopic study of intact eye-lenses; mathematical modelling of genetic and metabolic processes. (10) Reproduction: seminalplasmin; mechanism of action and modulation of effects of hormones in target tissue. (11) Osmoregulation: genetics of osmoregulation in *Escherichia coli*. (12) New Techniques: internuclear connections.

The Centre has excellent laboratory facilities and technological expertise of a high order for carrying out work in most of the disciplines of modern biology such as molecular biology, cell biology, genetics, microbiology, biochemistry, biophysics and theoretical biology.

The Centre selects students for Ph.D. programme twice a year during the months of January and June. It also attracts a large number of distinguished biologists from all over the world, who give lectures, take part in discussions or collaborate in specific research programmes.

The Centre, which was temporarily located earlier at the Regional Research Laboratory (RRL), Hyderabad, is now functioning from its own modern laboratory complex, adjoining RRL.

CSIR CENTRE FOR BIOCHEMICALS (CFB)

Guru Teg Bahadur Marg
University Campus, Delhi 110007
(Estd 1966)

Telegram : BIOCENTRE Telephones : 2518471, 2515602

Scientist-in-Charge : Dr A. P. Joshi, M.Sc., Ph.D., Dip. Biochem. Engg. (Lond.)

CSIR Centre for Biochemicals, earlier known as Biochemicals Unit, was established in 1966 as a grant-in-aid project of CSIR in Patel Chest Institute and was taken over by CSIR in 1977 as an autonomous laboratory. It was initially linked to CSIR as an autonomous laboratory under IICB-Calcutta. In December 1986, the Centre was delinked from IICB and started functioning as an independent laboratory of CSIR. The Centre was established with a view to helping the scientists working in the fields of life sciences by making available the necessary fine chemicals and enzymes for their research work.

The Centre has standardized the procedures for the production of a large number of biochemicals useful for the research in the field of biological sciences. In addition, the Centre is also active in upscaling technologies developed in the national laboratories.

Over the years, the Centre has made significant contribution in immunotherapy by preparing antigens for the diagnosis and treatment of respiratory allergy. It has also trained more than 300 clinicians by giving them training in the field of immunotherapy. In association with NBRI-Lucknow, the Centre has conducted an aerobiological survey of the pollen and fungal spores prevailing in the atmosphere in various parts of the country and has made a pollen calender which is useful to the allergic patients and the clinicians treating these patients. The Centre has already made a headway in making available eight national reference standards of allergenic extracts.

Several standard clinical diagnostic kits for the diagnosis of a number of diseases have been prepared by the Centre's scientists to bring about reproducibility of results in clinical pathology laboratories. It has made available these kits to many hospitals and clinics in the country. The technology for the manufacture of 14 such kits has been transferred to Northern Biological and Chemical (P) Ltd, Noida, U.P. Work is in progress

for developing new kits in collaboration with IICB-Calcutta and CDRI-Lucknow.

Three major projects have been sponsored at the Centre by the Department of Biotechnology and one by the Department of Nonconventional Energy Sources, respectively. Under the DBT project on oligonucleotide synthesis, the Centre has standardized preparation of various oligonucleotide-primers, linkers, adaptors and nucleotides of specified sequences according to the requirement of scientists working in the field of genetic engineering. Under the DBT project on production of restriction enzymes, the Centre has succeeded in preparing many restriction endonucleases, DNA/RNA modifying enzymes and DNAs from various sources. These enzymes are routinely made available to the scientists working in the field of genetic engineering. The third project deals with the establishment of a central facility for import and distribution of enzymes and fine chemicals not yet made indigenously. The main objective of this project is to provide the necessary chemicals at short notice, thus saving valuable time and hardship of import procedures.

The Department of Nonconventional Energy Sources has sponsored a project for upscaling a process already standardized at the Centre to bring about a three phase conversion of apple pomace into organic acids, hydrogen and methane. The work on setting up of a pilot plant on the site of HPMC, Parwanu (H.P.) is in progress.

INDIAN INSTITUTE OF CHEMICAL BIOLOGY (IICB)

4 Raja S.C. Mullick Road, Calcutta 700032
(Taken over in 1956)

Telegram : LIVINGCELL
Telephone : 463491 (3 lines)
Telex : 021-7108

Director: Dr S.C. Pakrashi, M.Sc., Ph.D., F.N.A.

The main objective of the institute is to carry out research in the basic biological sciences for seeking solution of medical problems yet unsolved, with emphasis on projects bearing on the current biological and medical needs of the country. With the growth and diversification of the medical and biological sciences over the years, the institute has developed into a truly multi-disciplinary unit. Its capabilities include among others, molecular biology & genetic engineering, microbiology, reproductive biology, enzyme chemistry & technology, process & fermentation biochemistry, pharmacology & experimental therapeutics, fundamental & applied biochemistry, immunochemistry, biophysics, membrane biology, biotechnology of natural products & medicinal chemistry, physiology, virology, parasitology, biochemical endocrinology, and computerized information storage and retrieval. The research work in this institute is grouped under seven major project areas, namely fertility management; enzyme engineering, diagnostics, tissue-targeted drug delivery, and hormones; leishmaniasis; *Vibrio cholerae*; medicinal chemistry and biotechnology of natural products; developmental neurobiology, and neurological disorders; and residue utilization.

The work in the institute relating to fertility management primarily aims at evolving safe and efficacious methods of population stabilization and centres mainly on the development of anti-fertility and anti-spermatogenic agents, immunological approaches towards birth control along with studies on sperm biology and uterine receptors.

In enzyme engineering, the programmes concentrate on the use of enzymes as diagnostic and therapy-monitoring agents. Experiments are being conducted on the modification of enzymes in such a way that these may be used as markers for the detection of antigens and antibodies for the diagnosis of various parasitic, bacterial and viral diseases. The enzyme-linked

antigens and antibodies can be used as immunodiagnostic kits for the detection of diseased states of individuals. Other diagnostic studies include nuclear imaging, while entrapment of drug in liposomes suitably designed to recognize and attach to diseased cells is being explored as a means of achieving tissue-targeted drug delivery so as to minimize the amount of drug required, and consequently its untoward side effects. Basic studies on extrathyroidal peroxidases form another important area of research under the programme.

Studies on leishmaniasis form an area of research in which the institute has developed expertise over long years of concerted work. Currently, emphasis is laid on a multidisciplinary molecular biological and biochemical approach towards understanding the basis of pathogenicity of *leishmania* for developing new chemotherapeutic leads, new drug-delivery systems, and reliable immunodiagnostic and immunoprophylactic methods.

Another area of extensive and sustained research of the institute has been cholera and its prophylaxis. A bacteriophage typing technique developed by the institute in 1963 for the identification of *cholera vibrios* and the epidemiological study of cholera received recognition by the World Health Organisation and has been cited internationally. Current work in the area is directed toward understanding the molecular basis of pathogenicity for developing suitable immunoprophylactic measures, and possibly an effective, long-acting oral vaccine for cholera.

In medicinal chemistry and biotechnology of natural products, the activities of the institute are concerned with the isolation, purification, and characterization of natural products of medicinal, biological, and industrial interest, and on the synthetic duplication of products of value. Emphasis is mainly placed on antifertility and antispermatogenic agents, cardiovascular and CNS-active drugs, and on alkaloids, polysaccharides, steroids, and marine products. Parallel pharmacological investigations, and mode and mechanism studies are also pursued.

In the programmes relating to developmental neurobiology and neurological disorders, stress is laid on understanding the cellular and molecular basis of brain development, genesis and prevention of movement disorders, neurotransmitter metabolism and regulation of cholinergic neurotransmission,

pharmacotherapeutics of venoms and toxins, inborn errors of metabolism leading to mental subnormality, and the identification of enzyme deficiencies and biochemical lesions for early detection of genetic aberrations amenable to therapy and genetic counselling of parents at risk.

The emphasis under the programme on residue utilization lies on the development of processes for making high-valued products of economic importance from low-valued materials. The current activities comprise: preparation of biochemicals for diagnostic, therapeutic and research uses from hospital wastes and agricultural products and byproducts; saccharification of polysaccharide reserves of agro-wastes and residues; isolation, purification and characterization of lectins; investigation of the biochemistry of seed maturation; and biohydrometallurgical studies.

The institute is currently pursuing a project on biohydrometallurgical extraction of copper from low and marginal grade sulphide ores sponsored by the Hindustan Copper Limited and has the following partially funded proposals in hand: chemical investigation of the constituents of *Cinchona ledgeriana* Moens bark (supported by the Department of Commerce & Industries, Government of West Bengal); hormonal regulation of reproduction in buffaloes (supported by the Department of Atomic Energy); molecular genetic analysis of DNA repair mechanisms (supported by the Department of Science & Technology); molecular mechanisms of enzymatic catalysis (supported by the Department of Science & Technology); and leishmaniasis (supported by the Indian Council of Medical Research). In addition, scientific collaboration in various disciplines is pursued with various universities and research organizations, and other CSIR laboratories.

Besides, a method of production of gelatin optical filters, which was commercialized, the institute has developed a viable process for the chemical conversion of quinine to quinidine, an anti-arrhythmic drug with anti-malarial properties as well, under a scheme sponsored by the Government of West Bengal which has been taking steps towards its commercialization.

The facilities available in the institute include: refrigerated centrifuges and ultracentrifuges, freeze driers, fraction collectors, spectrophotometers and spectrophotofluorimeters, liquid scintillation counters, research microscopes, video came-

ra with accessories, electrophoresis and electrofocussing equipment, mass spectrometer, HPLC apparatus, NMR instrument, electron microscope, amino acid analyzer, microfermenter, electronic stimulator, and computers. It has a well-equipped library, and a modern animal house.

IICB sponsors symposia, seminars, workshops and meetings in a broad array of disciplines relating to medical and biological sciences.

INDIAN INSTITUTE OF PETROLEUM (IIP)

P.O. IIP, Dehra Dun 248005
(Estd 1959)

Telegram : PETRINST
Telephones : 24508, 27031 (4 lines)
Telex : 0585-217

Director : Dr R. Krishna (on leave)
Acting Director : Shri Sudhir Singhal, M.S. (App. Phy. Sc.) (UK)

The institute has the mandate to: (1) undertake research and development work on processing and utilization of petroleum and its products, natural gas and petrochemicals; (2) conduct market surveys and techno-economic studies in these fields; (3) train personnel for the petroleum industry; and (4) assist the Bureau of Indian Standards in formulating standards for petroleum products, petrochemicals and appliances using petroleum fuels, lubricants and speciality products.

IIP provides technical back-up services to the petroleum refining industry in terms of evaluation of crude oils and products to provide necessary input for expansion schemes and revamps within the refineries. A major activity is the development of various processes for separation and for conversion. In the area of separation process development, extraction of aromatics from product streams is a major thrust area of IIP. R&D activities in this area are related to the manufacture of pure aromatics such as benzene, toluene, xylene from the reformed naphtha, dearomatization of naphtha to meet fertilizer and petrochemical feed stock requirements, dearomatization of Bombay High 63-69°C cut to make food grade hexane, dearomatization of Bombay High and Assam kerosenes for meeting ATF and superior kerosene specifications, deasphalting short residues for either lube base stock manufacture or for cracker feed stock preparation and extraction of polar compounds from vacuum distillates for lubricating oil manufacture.

IIP has developed, in collaboration with EIL, the technology for production of pure benzene and toluene from reformed naphtha. The experimental work to generate basic equilibrium and mass transfer data was carried out at IIP over a period of more than a decade. This information provided basic inputs for the process design and engineering which was done by EIL

This technology has also been extended to straight run naphtha to produce low aromatic naphtha suitable for fertilizer and petrochemical industries.

The technology for BT extraction has been commercialized at the Bharat Petroleum Corporation (170,000 tonnes/annum) and at the Cochin Refineries. Also, it will be possibly used at Saleempur. This technology has been accepted by Haldia Petrochemicals for the dearomatization of naphtha (500,000 tonnes/annum). For the development of the process for dearomatization of kerosene for ATF/SK requirements, the basic laboratory data generation has been completed and pilot plant commissioned which is being operated at HPCL, Bombay. This development by IIP, EIL and HPCL, will also be available in future for replacing older liquid sulphur dioxide technology, being used for this purpose in the eastern refineries.

Basic data have been generated to enable process design for manufacture of food grade hexane from 63 to 69°C cut using either extraction or extractive distillation. The process design and engineering work is being done by EIL at the instance of BPCL, Bombay and MRL, Madras for producing 25,000 tonnes/annum of food grade hexane. The technology for propane deasphalting has been accepted for the HPC and the Madras Refineries. This technology is now being extended to include deasphalting by use of higher molecular weight solvents such as pentane, iso-pentane or C5-C6 cut. In the area of extraction of vacuum distillate for lubes manufacture, studies at IIP are in progress for evaluation of NMP as an extraction solvent.

Another area of separation process development is solvent dewaxing and deoiling for which IIP, under the aegis of PPDCG (Petroleum Processes Development Coordination Group consisting of IOC, EIL, NRDC and IIP), has developed alongwith its partners, the capability for design and engineering of dewaxing and deoiling process. Pilot plant scale facilities are available at IIP and the studies carried out at the laboratories have provided inputs for debottlenecking of the Haldia Refinery lube complex.

In addition to the conventional methods of separation of aromatics from product streams (such as by liquid extraction), IIP is also investigating the possibility of using a liquid membrane process for dearomatization of naphtha and kerosene. Initial results have shown that the liquid membrane process

can offer a very efficient alternative to solvent extraction. Another novel concept, now being studied, is one wherein dearomatization of naphtha and kerosene can be combined in one process, leading to energy saving.

In the area of conversion processes, IIP has pilot scale facilities for visbreaking, under the PPDCG programme. The current programme of work has already provided technology inputs for refinery modification scheme at the Gujarat Refinery and for new refineries at Karnal. It is envisaged that further work will be undertaken to extend the visbreaking technology to include soaker operation. In addition to visbreaking pilot scale facilities, delayed coking facilities are also available.

In the area of catalytic processes, in collaboration with the French Institute of Petroleum, IIP has licensed know-how for hydrodesulphurization, catalytic reforming and two-stage hydrogenation of pyrolysis gasoline. To supplement the catalytic process development work, the institute has a programme of catalyst development for reforming and hydrocracking.

Several years of work at the institute has led to development of high purity alumina support for specific structure and mono and bi-metallic catalyst for catalytic reforming. The know-how for commercial production has been made available to the industry (IPCL-CATAD). IIP has been recently engaged in studies on hydrocracking and development of hydrocracking catalysts. The efforts in this direction have taken a quantum leap and extensive pilot and microscale testing and evaluation facilities have been set up at IIP with funds from the Oil Industry Development Board (OIDB).

Wax interaction and rheology of petroleum crudes and products is a new area of work which the institute has taken up. Most of the Indian crudes are rather waxy and tend to gel even above ambient temperatures particularly in winter. The liquid fuels derived from these crudes, for instance the diesel oil and fuel oil, are waxy and difficult to handle. In this context, for transportation, handling and processing of these crudes and the products derived from them, it is necessary to understand the role of wax, its interaction with the matrix, and resultant effects on the low temperature flow properties of these fluids. Only through such understanding, a rational approach, for synthesis of flow improvers can be obtained. A wax laboratory having highly specialized equipment needed for these studies has been set up with funds from OIDB. The results of IIP work

are useful in the development of tailor made pour point depressants.

Extensive facilities are available for the performance evaluation of fuels and lubricants on standard engines. The lubricating oils are evaluated for detergency, oxidation stability, bearing corrosion and sludge deposition characteristics, while gasoline and diesel are evaluated for octane and cetane numbers.

The institute develops test methods using indigenous engines with a view to substituting imported equipment. Studies on engine emission and pollution control are also undertaken. An indigenous smokemeter to measure the smoke emission in diesel vehicles has been developed and commercialized. Based on a state-of-art report prepared by IIP for the Department of Environment, Government of India, suggestions to control vehicle emissions were made to the government. 2T oil development to cater to the needs of various types of two stroke engines with newer technology and work on optimum octane requirements for engines are in progress.

In the field of conservation of petroleum products, IIP has developed and commercialized improved kerosene hurricane lantern, high efficiency kerosene wick stoves and fuel efficient low air pressure (LAP) industrial burner capable of using low grade fuel with a small quantity of excess air. Tribological studies are also undertaken to study the lubrication, friction and wear in industrial machines to improve productivity by reducing down time.

FIELD STATION

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   PO Jawaharnagar 392320
   Vadodara
   Telegram: CARE GUJREFIN
   Vadodara

INDIAN NATIONAL SCIENTIFIC DOCUMENTATION CENTRE (INSDOC)

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667009 & 667818
Telex : 031-2499

Acting Scientist-in-Charge: Shri S.K. Bhattacharya

INSDOC provides a wide range of documentation and information services in science and technology to information users. These services include compilation of bibliographies, preparation of current literature listings on specific topics, document copy supply, translation of documents from other foreign languages into English, reprography, and printing. The other functions of INSDOC are: development of a document resource base, computer-based information storage and retrieval, preparation and publication of information access tools and referral directories, education and training for information manpower development, information use promotion, etc.

The National Science Library (NSL) of INSDOC builds up a document resource base in science and technology. This collection development is based upon the principle of resource sharing and cooperative acquisition, keeping in view the resources available in other scientific and technical libraries in the country. The national collection is integrated through the National Union Catalogue, giving a complete view of the holdings of the libraries in the entire country. INSDOC is also holding a rich collection of Russian scientific publications, being received from USSR under the Russian Science Information Centre project.

The computer-based information storage and retrieval activities of INSDOC mainly relate to Union Catalogue data processing, index preparation of Indian Science Abstracts (ISA), National Index of Translations (NIT), processing of data and preparation of statements for the Centralized Acquisition of Periodicals (CAP) project, and preparing various listings and indexes for the directory type publications which are brought out at different periods and updated. Be-

sides the in-house HP 1000 mini-computer and a PC linked to NEC 1000 both installed by the National Informatics Centre (NIC), INSDOC has installed a PSI SIRIUS-32 and a few more PCs. The comptuer systems of the Delhi University, NIC and the Indian Institute of Technology, Madras, are also used.

INSDOC brings out: (1) *Indian Science Abstracts* (fortnightly) which represents a complete record of current Indian scientific literature. This is presently available in print form; (2) *Contents List of Soviet Scientific Periodicals* (monthly) covers 120 select Russian scientific journals; (3) *National Index of Translations* (NIT) (monthly) carries 250 items of translations with computerized author and permuted subject indexes; (4) *Accession List of Russian Scientific and Technical Publications* is a bimonthly publication; (5) *Annals of Library Science and Documentation* (quarterly) is a primary periodical.

A *Union List of Current Scientific Serials in India* has been brought out which records about 13,000 titles of scientific serials being received in 785 libraries. This is also held in machine readable form. A database of holdings of scientific periodicals in 800 Indian libraries has been built up with records of about 15,000 current scientific serials. This is also held in machine readable form. A printed edition of the *National Union Catalogue of Scientific Serials in India* has been brought out.

INSDOC has brought out two state-of-art report publications: (i) 'Solid waste management in developing countries', (ii) 'Recent trends in wind energy', in collaboration with National Environmental Engineering Research Institute, Nagpur and National Aeronautical Laboratory, Bangalore, respectively. A number of referral directories such as *Directory of Scientific Research Institutions in India* (1969); *Current Research Projects in CSIR Laboratories* (1972, 1976 and 1981); *Directory of Indian Scientific Periodicals* (1968, 1976) have also been published. The first has been updated and is in the press to be released shortly. These referral directories are also held in machine readable form. The institute has also compiled: *Directory of Scientific Research in Indian Universities* (1974), as a joint project of the University Grants Commission and CSIR, and a *Directory of Testing Facilities*, under a contract from the Department of Science and Technology.

INSDOC conducts a two-year advance training course leading to Associateship in Information Science, recognized as equivalent to master's degree in the subject. Occasional courses on continuing education programmes on specific areas of information and documentation, reprography and micrography and translation are also conducted. User education programmes are also conducted at frequent intervals for various groups of user communities.

INSDOC has been actively involved in research studies on bibliometrics. Presently, these studies have been confined only to analyzing research outputs of CSIR scientists on the basis of citation pattern.

INSDOC has also been involved in the promotion of use of information. As this has to be cultivated from school level, INSDOC has developed a library instructional programme for science students in schools. Two tape-slide programmes of about 40 minutes duration have been developed and demonstrated at a number of schools. As these programmes have been received very well, INSDOC proposes to develop these presentations with the support of agencies like National Council of Educational Research and Training (NCERT). A number of user studies have been made at INSDOC to assess the utility of Indian Science Abstracts, Union Catalogue, and document copy supply service with a view to improving the quality of these publications and services.

INSDOC has a wide range of equipment for providing reprographic and micrographic services. These include Xerox 1385, Canon NP 210, Ubix 600W II, microfilming cameras, Dagmar microfiche camera, Gestafax Es 390 electronic stencil cutting machine, Coronastat 44 SCM electrostatic copying unit, Savin 220 electrostatic copier, Minolta reader printer RP 505, and Minolta copier 450Z. It also has modern capability potential for undertaking jobs for printing of 30,000 to 35,000 pages per year. The printing unit is equipped with IBM composers, electronic (network) typewriters, besides a wide ranging machines for offset printing.

Three INSDOC Regional Centres, one each at Bangalore, Calcutta and Madras have been established. Of these Bangalore Centre has been functioning for the last 20 years. This Centre is well developed and has been using the resources of the Indian Institute of Science for its activities. The other

two regional centres are offering document copy supply services at present.

INSDOC collaborates with international and national organizations engaged in documentation and information fields. It represents India as a national member of the International Federation for Documentation (FID). The FID Committee for Informetrics (FID/IM) is operating its activities from INSDOC. INSDOC is also actively associated with PGI (General Information Programme), Unesco. INSDOC collaborates with the Bureau of Indian Standards for the preparation of standards for documentation.

FIELD STATIONS

1. INSDOC Regional Centre
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2. INSDOC Regional Centre
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   4, Raja S.C. Mullick Road
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   Telegram: CARE LIVINGCELL
   Telephone: 424883

3. INSDOC Regional Centre
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   Telegram: CARE CONSEARCH
   Telephone: 411453

INDUSTRIAL TOXICOLOGY RESEARCH CENTRE (ITRC)

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(Estd 1965)

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PBX-40106, 7, 8
Telex : 0535-456-ITRC IN

Director : Dr P. K. Ray, Ph.D., D.Sc.

The aims of the laboratory are to : (1) identify through systematic epidemiological surveys on the occupational health hazards faced by industrial and agricultural workers; (2) undertake safety evaluation of industrial and environmental chemicals; (3) conduct experimental studies on the mode of action of industrial chemicals/environmental pollutants; (4) develop suitable diagnostic tests for environmental pollutants and diseases caused by them and suggest remedial/preventive measures; (5) conduct monitoring studies on environmental pollution; and (6) collect and disseminate information on hazardous chemicals.

ITRC has three units: (a) main campus at Mahatma Gandhi Marg, Lucknow; (b) Gheru Campus, Gheru, Lucknow; and (c) Occupational Health Centre, Kanpur.

ITRC pursues experimental studies on the toxicity of synthetic dyes, food contaminants, heavy metals, pesticides, mineral dust, vegetable dust, fibres, plastics, solvents and mineral oils, biological monitoring of pesticides residue levels, monitoring of levels of chemical pollutants and noise in work and living environment, and health surveys and industrial hygiene studies in industries with a potential for occupational hazards. The studies are carried out from the angles of predictive and preventive toxicology, so that the identification of problems and their solutions are possible. Multidisciplinary capabilities and facilities of international calibre are available in the following sections : Epidemiology of Occupational Diseases, Pesticide Toxicology, Petroleum Toxicology, Food Additive Toxicology, Toxicokinetics, Environmental Monitoring, Analytical Toxicology, Neurobehavioural Toxicology, Developmental Toxicology, Immunotoxicology, Preventive Toxicology, Biotechnology, Environmental Microbiology, Immunobiology, Phototoxicology, Phytotoxicology, Ecotoxicology,

Cardiovascular Toxicology, Pulmonary Toxicology, Aquatic Toxicology, Genotoxicology, Environmental Monitoring, Toxicological Documentation, and Information Science.

The laboratory is associated with three National Science and Technology Mission Programmes : (1) Central Ganga Action Plan : Water samples from 28 points from Gangotri to Gangasagar are analyzed every month for assessing the level of pollution caused by heavy metals and 11 pesticides, as a sponsored project of the Central Ganga Authority. (2) Safe Drinking Water Mission : Country-wide survey of quality of drinking water vis-a-vis pathogens and pollutants with particular reference to remote, rural and backward areas has been completed. Investigations on removal of pathogenic microbes from contaminated supplies of drinking water by appropriate filtration techniques are in progress and a potable water analysis kit has been developed. ITRC is the coordinator for the project for northern and eastern states for the Ministry of Rural Development. (3) Edible Oil Programme : Safety evaluation of various new sources of oils intended for human consumption throughout the country is being undertaken.

Provision of expertise, facilities and know-how in all aspects of predictive and preventive toxicology of industrial and agricultural channels of natural relevance, and development of national guidelines for hazardous chemicals are envisaged under the National Toxicology Programme. The laboratory carried out post-effect study on the survivors of gas leakage tragedy in Bhopal, for immediate and long-term effects and submitted reports to the authorities. Experimental studies to elucidate the mechanism of toxicity of methyl isocyanate, sponsored by the Central Cabinet Commission, are in progress.

The ITRC in-house research programmes relate to : (1) Dyes and Food Contaminants— (a) Toxicity of colouring chemicals to industrial workers (a simple diagnostic test for evaluating exposure and methods to reduce dermal reactions have been developed); and (b) Assessment of contamination of food items by non-permitted colours and adulterants and the health risks to people in rural and urban areas all over India through exhaustive surveys, toxicity testing and development of simple testing procedures to detect toxicants. (2) Heavy Metals— Effect of toxic heavy metals, alone and in combination, on central nervous system, behaviour, reproductive system and on development, and combined effects of superim-

posed malnutrition and therapeutic measures for heavy metal toxicity and models for toxicokinetics (An all India survey of assessing risks of heavy metal pollution through water, soil and food has been completed). (3) Pesticides— (a) Effect of various agrochemicals used in the country on neurobehavioural, respiratory, cardiovascular and reproductive systems; (b) Safety evaluation of various toxic chemicals by a standard battery of tests for acute, sub-acute, chronic and genetic toxicity including cancer and any malformation in new borns; (c) Evaluation of undesirable effects on plant systems and development of resistant strains through tissue culture; (d) Evaluation of pesticides residues in various biological tissues, food and water collected from different parts of the country, (e) Phototoxic effects on skin as a result of exposure to chemicals and sunlight. (4) Plastics and polymers— (a) Neurobehavioural toxicity and developmental toxicity of various ingredients, (b) Safety evaluation of plastic containers and medical equipment, (c) Microbial technology for biodegradation. (5) Particulate air pollutants—Evaluation of the effect of industrial and mining dusts and fibres on respiratory system and predictive toxicity with asbestos, silica, fly ash, coal, etc. (6) Environmental carcinogenesis— (a) Evaluation of potential cancer risk by several industrial chemicals (e.g., jute batching oil) and biochemical mechanisms involved; (b) Mutagenecity testing by plant, animal, insect and microbial test system; (c) Two stage bioassay for carcinogenecity evaluation of referred chemicals. (7) Preventive Toxicity— (a) Development of immunological and chelation methods for treatment of toxic conditions including chemical induced cancer; (b) Pollution prevention by converting toxic pollutants to useful commodities by microbial technology, such as conversion of distillary waste to biogas. (8) Immunotoxicology— (a) Effect of industrial chemical on the body defence mechanisms and means to control it, and immuno-prophylaxis of toxic conditions using specific immunomodulations and other defensive mechanisms. (9) Petrochemicals— (a) Effect of industrial solvents on haemapoietic systems; (b) Capabilities for evaluation of the ecological impact of effluents from petrochemical industry and food items made by using effluents for irrigation (Detection of exposure in petroleum workers by a new method involving urine testing has been made possible); (c) Evaluation of the safety of microbial (single cell) proteins manufactured from

non-conventional sources. (10) Environmental monitoring— Quantification of pollutants in workroom, community and in the environment for toxic dusts, gases and noise levels, and environmental impact assessment of industries and related industrial hygiene parameters. (11) Epidemiology— (a) Health surveys of factory workers exposed to hazardous substances, such as in electronics, heavy electricals, synthetic chemicals, slate, textile industry, etc; (b) Water analysis of samples for pollution control board; (c) WHO sponsored Health and Environment Programme through Occupational Health Centre at Kanpur is to start soon.

ITRC and its two units provide services to industry and regulatory agencies in every field of toxicology. It undertakes : health surveys of workers exposed to toxic hazards; environmental surveys for different levels of noise, metals, gases, dust and chemical pollutants; and analytical studies on industrial and agrochemicals. It prepares status reports on pesticides/ toxic chemicals and evaluation of safety.

ITRC renders technical advice to regulatory agencies on standards of air-water quality, chemical safety, food additives, and pesticides under the Insecticide Act. ITRC has set up the guidelines on threshold limit values of hazardous chemicals in industry. It acts as a Referral Centre on occupational diseases for compensation under ESI, and it has prepared a know-how on chemical disaster preparedness plans onsite and offsite, and follow up.

ITRC offers training programmes of short-term and long-term courses on industrial toxicology, occupational health, industrial hygiene and analytical methods. It has an Environmental Information System on Toxic Chemicals (a Distribution Information Centre for the Department of Environment), and also a Toxicity Data Unit.

Atomic absorption spectrometer, microprocessor-controlled gas liquid chromatograph; high pressure liquid chromatograph (HPLC), direct-current plasma-atomic emission and inductively coupled plasma-optical emission spectrometers, plant physiology meter, optovarimex computerized animal activity monitor, blood gas analyzer, gas exposure chamber, elisa processor and solar simulator are some of the modern instruments available at the laboratory.

ITRC interacts with international agencies on aspects related to toxicology : ITRC is the National Correspondent for col-

laboration with International Register of Potentially Toxic Chemicals set up by United Nations Environment Programme. It is the nucleus for a lead institution under the Information Programme on Chemical Safety set up by World Health Organisation. ILO, WHO, UNEP support specific training programmes of ITRC.

ITRC publishes : *Industrial Toxicology Bulletin* (six monthly) and *Current Literature in Toxicology* (quarterly, published in collaboration of the Department of Environment).

FIELD STATIONS

1. ITRC Gheru Campus
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   Lucknow
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2. ITRC Occupational Health Centre
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INSTITUTE OF MICROBIAL TECHNOLOGY (IMTECH)

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(Estd 1984)

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Director: Dr S.K. Basu, Ph.D.

Youngest among the CSIR constituents, IMTECH has been set up with a view to carrying out research in the frontier areas of microbial technology and genetic engineering. The research laboratory (start-up laboratory) of the institute, located at 177-G, Industrial Sector, Phase I, Chandigarh, has been functioning since January 1984. The institute's main laboratory building is being planned and is expected to be ready soon.

The objectives of IMTECH are: (1) To provide an integrated research development and design base for microbial technology; (2) To undertake basic and applied research and development programmes in established and emerging areas of relevant biotechnology, including genetic engineering; (3) To optimize the existing microbial processes currently available and in use in the country; (4) To develop and maintain gene pool resources and genetic stocks of microbial cultures and other cell lines (This would also serve as a reference centre to assist other centres.); (5) To establish facilities for biochemical engineering, development of instrumentation, including microprocessor systems, and for development of mathematical models for process parameters; (6) To establish facilities for design of process equipment and bio-reactors; (7) To impart training in microbiology, microbial technology and biochemical engineering to research workers and technologists; (8) To establish documentation and information retrieval, and dissemination facilities and a data bank to meet the needs of the institute; (9) To establish and maintain effective linkages with industry and eductional institutions; (10) To develop capabilities for producing design and engineering packages for industrial plants; and (11) To undertake sponsored R&D work of national importance in the field of biotechnology.

The current research programmes of the institute include:

(1) Industrial ethanol fermentation: Construction of improved strains by genetic manipulation and process optimization; (2) Rifamycin fermentation: Genetic and biochemical approaches for improved process development; (3) Isolation and cloning of plasminogen activators from animal cells and cloning of plasminogen activator coding sequence in *E. coli*; (4) Molecular approach to control rotavirus (a diarrhoea virus) pathogenesis; (5) Selective delivery of antileishmanial drugs to macrophages; (6) Novel petroleum exploration strategies: A feasibility study for developing genetic and immunological approaches for detection of microflora diagnostic of oil-bearing formations; and (7) Development of computer software for molecular biology. The institute with its gradual expansion will be diversifying its activities as defined under its objectives.

IMTECH has been entrusted with the creation of three national facilities as a collaborative venture between CSIR and the Department of Biotechnology: (i) Microbial Type Culture Collection/Gene Bank: When fully functional, it will maintain a large and authentic collection of microorganisms (bacteria, yeast, fungi and mycoplasma) as well as gene banks and will serve as a depository of microbes including patented cultures, genetically manipulated microorganisms and gene banks in various vectors. It will act as an agency for the distribution of authentic strains for research and industrial use. For this purpose, modern facilities for identification and preservation have been set up. (ii) Biochemical Engineering Research Centre/Pilot Plant: Expected to be fully functional soon, BERC will undertake R&D work in the process engineering aspects of existing and new biochemical and microbiological technologies and also for proving technologies proposed to be imported by private or public sector enterprises. Universities and other smaller centres with inadequate scale-up facilities would be able to utilize the large scale facilities at BERC for process development. The centre is being equipped with state-of-art scale-up and down-stream processing machinery necessary for fermentation based processes. (iii) Distributed Information Centre on Bioinformatics: Under Department of Biotechnology's Biotechnology Information System (BTIS) network, the institute has been chosen to house a DIC on enzyme engineering, immobilized biocatalyst, micro-

bial fermentation and bioprocess engineering. The Centre is being equipped with Microvax II computer system.

IMTECH is well equipped with most of the necessary equipment needed for R&D work in the fields of molecular biology, genetic engineering and applied microbiology. It has, for example, refrigerated centrifuges, fluorescence microscopes, atomic absorption spectrophotometer, computer controlled fermentors of various capacities, gas chromatograph, spectrofluorometer, tissue culture CO_2 incubators, ultra-low temperature freezers, microform reader/printer, scintillation counter, ultracentrifuges, high performance liquid chromatograph, fast protein liquid chromatograph, IR spectrophotometer, UV/VIS spectrophotometers with recording facilities, microcalorimeter, freeze dryer, UV illuminator with camera attachment for gel electrophoresis, cold room, temperature controlled rooms and other test and analysis facilities. The institute has a reasonably good stock of various biochemicals and radioactive chemicals needed for research work. It also has a small but well-stocked library of current journals, serials and books covering the areas of biosciences and biotechnology.

NATIONAL AERONAUTICAL LABORATORY (NAL)

Laboratories: Kodihalli, Bangalore 560017
Wind Tunnel Centre, Belur 560037
(Estd 1959)

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53351-54, 55795-99 & 50796
Wind Tunnel Centre: 579611-18
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Director: Prof. R. Narasimha, B.E., A.I.I.Sc., Ph.D. (Caltech), F.A.Sc., F.N.A.

NAL is devoted primarily to research and development in aerospace engineering and contributes to the country's endeavour for self-reliance in this vital sector. The laboratory undertakes forward looking R&D in close interaction with the user industry and other research organizations.

The problems of aerospace research being complex and multi-disciplinary in nature, NAL has built sophisticated facilities and expertise to provide R&D support in the areas of Aerodynamics, Fluid mechanics, Materials science, Propulsion, Structural sciences and Systems engineering. Built around each area is a scientific division of the laboratory. These divisions are supported by the Computer Centre, the Engineering Services Division, the Graphic Arts Section, and the Information Centre for Aeronautics. The Technical Liaison section and the Project Monitoring section assist the Director in planning and management of the programmes of the laboratory.

The Computer Centre has a Sperry Univac 1100/60-H1 system with a 524 kb memory and with multi-programming and time sharing facilities. A unique feature of the Centre is a graphic facility, Autotrol AD 380, for computer-aided design. The Information Centre for Aeronautics has an impressive collection of books and periodicals and also offers a wide variety of services.

The laboratory has established a number of major research/test facilities, some of which are considered National Test Facilities:

(i) National Trisonic Aerodynamic Facility (NTAF) has a series of wind tunnels with supporting infrastructural facilities such as a model preparation shop with a CNC machine, powerful computer based data acquisition and processing

facility and a 66 kV electric substation. The 1.2 m wind tunnel is a major facility, the only one of its kind in the country. A second major tunnel (0.6 m) chiefly for testing at transonic speeds is now being added to this facility. It is expected to become operational soon. Besides saving foreign exchange to the tune of several crores, the facility generates valuable and crucial design data for national aerospace projects such as the LCA, ASLV and PSLV projects.

(ii) A 24 Actuator Computer Controlled Full Scale Fatigue Testing Facility has been set up for evaluating service fatigue life of fighter aircraft. Fatigue life evaluation programmes have been completed on Gnat and Ajeet airframes resulting in improved safety and considerable indirect economic benefits through life extension by suitable strengthening modifications. This facility is being augmented and improved to take up the life evaluation programme on LCA in the future.

(iii) A new Acoustic Test Facility has been recently designed, built and commissioned at the Belur Campus. This facility has been set up primarily to meet the needs of the Indian Space Research Organisation, which funded the building of this facility. This unique facility, first to be built in the country, is used for subjecting satellites and launch vehicle segments to the acoustic loading they experience during launch and studying how they respond to and survive, the acoustic environment. In the past, one had to go abroad for such testing involving considerable expenditure in foreign exchange (approximately of the order of 70 lakh per test). Since commissioning, three test programmes on satellites have been completed.

(iv) Another major facility that has been recently commissioned is the Computer Assisted Vibration Test and Analysis System (CAVITAS). This system, jointly developed by NAL and HCL (Hindustan Computers Ltd), enables vibration tests to be conducted on a complete airframe, with data acquisition and analysis carried out on-line to obtain dynamic characteristics of the airframe.

(v) Other major facilities are the CLOCTER and the Autoclave. The CLOCTER facility (CLOsed Circuit Compressor TEst Rig) is used for research and developmental work relating to centrifugal compressor stages such as those used in turbochargers, multistage industrial compressors, aero-

engines and refrigeration systems. The Autoclave, first of its kind to be indigenously designed and developed, is an important facility in which structural components made out of carbon fibre resin composites are subjected to temperature and pressure to cure them to final shape. This facility is one of the large autoclaves now operational in the country (2.4 m diam, 6 m long) and is currently being used for fabrication of carbon fibre reinforced plastic rudder for aircraft.

Apart from these major facilities, NAL has also set up pilot plants for fibre reinforced plastics and transducer/data systems. These are used to productionize the developments made in the laboratory before transfer to industry for adoption. In addition to the scientific divisions mentioned earlier, NAL has a wind energy group involved in the development of wind mills for lifting water, power generation and also in conducting wind surveys to identify promising sites for tapping wind energy. A few interdivisional groups have also come into being in the recent past to operate research and development projects, which are multidisciplinary in nature.

The laboratory's activities currently in progress in the different scientific divisions are formulated on the basis of the laboratory's charter, the needs of the major national aerospace programmes, and the advice of a high level scientific committee called the Research Advisory Council. These activities, can be grouped into the following major R&D programmes.

1 R&D programmes relating to the National Aerospace Programmes such as the Light Combat Aircraft (LCA), the Augmented Satellite Launch Vehicle (ASLV) and the Polar Satellite Launch Vehicle (PSLV) programmes : These R&D programmes are being carried out in most of the scientific divisions and are funded completely by the Aeronautical Development Agency and Indian Space Research Organisation. Work on the LCA related R&D projects is a major thrust area of NAL. The Aerodynamics Division of NAL and the NTAF are involved in extensive wind tunnel testing of various stages of configurations of LCA to obtain crucial design data and launch vehicle models to investigate booster separation trajectories and buffeting phenomena. The Structures Division is involved in aeroelastic investigations on the launch vehicles The Materials Science Division is involved in evaluating Al-Li alloys for application to LCA. Similarly,

other divisions are involved in investigations on a number of problems relating to LCA, PSLV and ASLV programmes.

2. Composite Materials and Structures Technology: R&D programmes in this area are being carried out in the Structures and Materials Science Divisions. Development of aramid fibres, similar to kevlar 49, high performance resins, and development of fibre reinforced Al-Li alloy laminates are some of the major R&D programmes currently in progress in the Materials Science Division. Research on delamination stress fields; development of advanced techniques for analysis of composite structures; design, fabrication and certification of flight worthy carbon fibre reinforced plastic (CFRP) rudder for military (MiG 21M) and civil aircraft (Do 228) are some of the R&D programmes in progress in the Structural Science Division. The development of a rudder for Do 228 is a joint collaborative programme between NAL and DFVLR, Germany.

3. Development of software for design and analysis in thermal, fluid and structural sciences: A large number of codes have been developed to handle a variety of problems in heat transfer, fluid flow and stress analysis. These codes have been installed on the Sperry Univac Computer. Advanced general purpose programs such as ASKA and NASTRAN (CSA) for static and dynamic analysis of structures have also been installed on the Univac. These programmes/codes are being extensively used by a number of DRDO establishments, the Aeronautical Development Agency, HAL and ISRO for their major aerospace and missile development programmes. The need for a Super Computer for highly involved computations relating to analysis of complex flowfields around aircraft configurations has been felt rather seriously. The non-availability of such computers from advanced countries is one of the reasons why NAL has launched intense efforts to develop parallel computing technology and adopt it to solve complex flow problems.

4. Flight Mechanics and Flight Research: This is an area in which NAL has been active in the recent years. As part of the activity in this area, NAL has built an all fibre glass aircraft of Rutan long Ez canard design. Building this aircraft using rigid foam has given valuable hands-on experience in the rigid foam-fibre glass fabrication technology. This is the first aircraft of its kind in the country. This has been built to

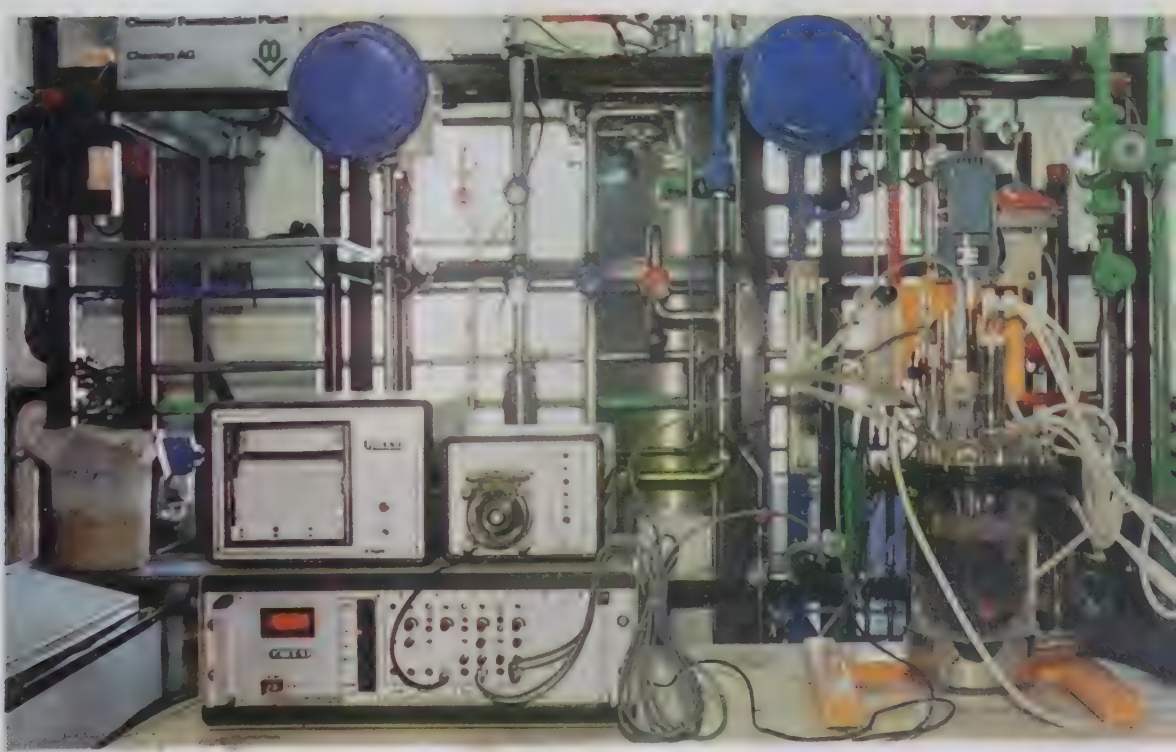
serve as a platform for flight experimentation to try out new technologies such as fly-by-wire controls. The aircraft made its first successful flight on 26 February 1987 and has been granted airworthiness certificate in the experimental category by DGCA. Activity in flight mechanics is largely concentrated in the Systems Engineering Division. The Division, which receives assistance in this area from aerodynamics and other divisions, has now sufficient expertise in aircraft parameter estimation from flight data. It has also built a dynamic wind tunnel in which models can be flown with limited degrees of freedom by remote controlled actuation of the control surfaces of the model, and the control laws, stability derivatives, etc. can be obtained. The division is also active in the development of flight instrumentation.

5. Energy-related Research: The laboratory is involved in a number of energy-related research projects. These projects are being carried out by the Propulsion Division and the Wind Energy Group. Work is going ahead with the second phase of its sludge gas energy project. The novelty of this project is that it uses gas turbines derived from aircraft after their normal flying life is over; a number of such engines are available within the country, and at throw away prices. A preliminary study reveals that if the sludge gas is assumed free of charge, the cost of power generation would be in the range of 18 to 23 paise per kWh. In collaboration with the Geological Survey of India and the Himachal Pradesh State Electricity Board, a Closed Loop R113 Rankine Turbopack System has been designed and fabricated for 5 kW geothermal power generation. The plant will be located at Manikaran, Himachal Pradesh. In the Wind Energy Programme, a major recent exercise has been the micro-survey conducted in various parts of the country in order to locate high wind sites; such surveys are important because other studies have revealed that proper siting is crucial for the success of any wind energy programme in the country.

6. Research in Turbomachinery: Research programmes, relating to design of efficient turbine and compressor blade profiles and their evaluation using cascade tunnel are in progress in the Propulsion Division.

7. Airworthiness-related Research: A whole spectrum of applied and basic research activities, in the area of fatigue and fracture, as related to durability and safety of fighter air-

IIP-EIL aromatics extraction process unit at BPCL, Bombay



Animal cell culture fermenter : IMTECH, Chandigarh

OPTO-VARIMEX-3/831 computerized animal activity monitor at ITRC, Lucknow

NEERI's anaerobic packed bed reactor for distillery spent wash, installed at Ajudhia Distillery, U.P.

NAL's light canard research aircraft

Cavitas facility at NAL, Bangalore for structural analysis

A view of the vitamin B_6 plant set up by Lupin Laboratories Pvt. Ltd, Bombay, at Ankleshwar, based on NCL technology

Xylofining plant of IPCL, Vadodara, which uses the NCL catalyst, ENCILITE-1

craft is in progress in the Materials Science Division. Evaluation of materials for fatigue crack growth under flight simulation load testings, both experimentally and theoretically, modelling of the fatigue crack growth process leading to development of analytical methods of crack growth analysis, and fatigue life evaluation of air frames by full scale fatigue testing are some of the main activities in the area of fatigue and fracture.

Failure analysis and accident investigation is an area in which NAL has been very active and has earned a reputation in the country. The Failure Analysis Group of NAL has been closely involved in practically most of the aircraft accident investigations during the past decade; the Group played a key role in the investigations into the Air-India *Kanishka* accident. One of the senior scientists of the Group in fact acted as an assessor on Justice Kirpal's Court investigating the accident and oversaw the technical investigation conducted for the enquiry. The Material Science Division of NAL has also developed the AVRA (Automatic Visual Range Assessor) system which can measure and report every 15 seconds the meteorological visibility (MV) and the runway visual range (RVR). The importance of this information at airports and airfields needs no emphasis. The technology of AVRA has been recently transferred to BEL, Bangalore.

8. Fabrication Technology: NAL has been involved in developing new fabrication technologies such as electrochemical machining (ECM). The laboratory has built electrochemical machining equipment and this has been used to make nozzle rings, a component of turbocharger of diesel locomotives. This technology is in the process of being transferred to industry. The laboratory had earlier developed Electro Discharge Machining (EDM) technology which has already been transferred to industry.

Besides its inhouse projects, which are designed to meet the long term needs of the aerospace industry, NAL works on several sponsored projects for user agencies such as HAL, ISRO, DRDO and IAF to meet their immediate and short term requirements. In addition, NAL extends advisory consultancy to public and private sectors of industry and offers its facilities for extensive specialized testing and analysis. The laboratory brings out a monthly newsletter and its annual reports besides several internal publications (about 250 every year).

NATIONAL BOTANICAL RESEARCH INSTITUTE (NBRI)

Lucknow 226001
(Taken over in 1953)

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Telex : 0535-315

Director : Dr P.V. Sane, M. Sc. (Ag.), Ph. D. (Alberta, Canada)

The National Botanical Research Institute aims at the best possible utilization of the non-traditional, under-utilized economic plants through introduction, domestication, conservation, protection, genetic upgrading and propagation and development of production technologies for new plant resources.

The R&D effort of the institute is geared to : Basic and applied botanical and phytochemical researches, demonstration and extension of technical know-how, and collection and dissemination of information. The institute's activities fall into six multi-disciplinary areas : (1) Taxonomy and Ethnobotany : Ethnobotany, and Seed biology including seed herbarium; Angiosperm taxonomy, Cryptogamic botany (lichens, bryophytes and pteriodophytes), and Palynology (taxonomic studies); (2) Plant Wealth Utilization : Pharmacognosy, Plant breeding and genetics, Natural polymers, Aromatics and vegetable colours, Pharmaceutical chemistry, Proteins, and Betelvine; (3) Floriculture : Botanical garden, Floriculture, Fungal pathology, Agro-botany, Cytogenetics, Mutation breeding, Plant introduction, and Virology; (4) Environmental Sciences : Environmental botany, Aquatic botany, and Palynology (aerobiological studies); (5) Plant Biotechnology : Biochemistry, Phycology, and Tissue culture; (6) Tree Biology : Biomass, and Reproductive biology of soft woods. Besides these, there are four national facilities, viz. Banthra Research Station including Usar land reclamation and utilization farm at Aligarh, Economic Botany Information Service (EBIS), Botanic Garden, and Herbarium. There are also four infrastructural facilities, namely Information (including Public Relations) and Library; Museum and Photography; Scanning- and Transmission Electron Microscopy; and Essential Services. The PME cell carries out the Planning, Monitoring and

Evaluation of the institute's on-going projects as well as the national and institutional facilities.

NBRI comprises a well laid out botanic garden (27 ha); a rich herbarium (having well over 1,00,000 plant specimens, properly identified, classified and incorporated, and more than 15,000 carpological collections (comprising fruits and seeds); a voluminous library [45,000 books and bound periodicals, 14,000 reprints, 450 reprographic material (microfilms, microfiches, etc.) and 577 national and international current periodicals], which also houses a Patents Inspection Centre; well equipped laboratories; and a field research station at Banthra, having a manmade forest (1 ha), a biomass research centre (10 ha), two betelvine conservatories, a central herb garden, an 'Avecenna avenue', besides plantations of petrocorps, damasc rose, etc. The garden has two arboreta, a rosarium, a conservatory, a cactus house, a succulents house, a palm house and a fern house. It has a large collection of indigenous and exotic wild and cultivated piants, all totalling to 6,000 taxa.

In order to provide the floriculture industry a firm scientific base, NBRI makes concerted efforts for : creating novelty in scented and non-scented ornamentals, domesticating wild indigenous plants of potential ornamental value, producing seeds of hybrids and polyploids and working out plant protection measures for these crops.

The NBRI's notable achievements include : production of more than 100 new cultivars of such popular ornamentals as amaranths, antirrhinum, bougainvillea, chrysanthemum, erythrina, gladiolus, marigold, *Nyctanthes arbortristis (Har Singar)*, perennial portulaca, rose, tuberose, and verbena; stretching of flowering period of chrysanthemum from the usual six weeks to all the year round; development of 'no pinch-no stake' garland making varieties of chrysanthemum; adoption of new techniques for cultivation (such as aesthetic culture) and training of chrysanthemum; domestication of wild plants of ornamental value; perfection of technology for raising F_1 hybrid marigold; rapid mass propagation of some difficult to grow orchids by tissue culture; micropropagation of some important ornamental and other economic plants; and formulations for prolongation of vase-life of cut flowers. The development of a process for the dehydration of fresh flowers, foliage and twigs has opened up immense possibilities in the area of floral crafts.

R & D work carried out at the institute on pharmaceutical plants has led to : correct botanical identification of a large number of herbal drugs and formulation of standards for many of them; development of a method for the mass propagation of *Dioscorea floribunda* by tissue culture; development of 3 hybrid opium poppy *(Papaver somniferum)* varieties, development of a complete package of agronomical practices for commercial production of *Matricaria chamomilla* German chamomile); designing of a new apparatus for preparation of 'attars' and perfumed water; and development of a process and a field distillation unit for distillation of rose oil from *Rosa damascena* flowers.

A process for the pilot plant cultivation of a protein rich blue green alga *(Spirulina platensis)* has been standardized in raw sewage, yielding 50-55% crude protein to be used as an ideal poultry feed mix. The technologies for commercial-scale cultivation of winged bean *Psophocarpus tetragonolobus)* and cottage-scale cultivation of six edible mushrooms *Agaricus bisporus* (Button mushroom), *Volvariella volvacea* (Paddy-straw mushroom), *Pleurotus sajor-caju, P. cystdiosus, P. flabellatus* and *P. eous* (all the four Dhingri mushrooms) have been developed and released to cultivators.

The agrotechnologies for some unusual economic plants such as petro-crops *(Euphorbia tirucalli)* alternative source of rubber *(Parthenium argentatum),* diosgenin yielding plant *(Kallstroemia pubescens)* and jojoba *(Simmondsia chinensis)* as substitute for the sperm whale oil, have also been developed.

The NBRI has at hand an ambitious demonstration, experimentation and awareness programme for carrying the economically exploitable results of its researches to villages for their economic uplift. Consequently, cultivation of grapes, winged beans and German chamomile; improved methods of cultivation of betelvine; and cottage-scale cultivation of some forms of edible mushrooms have already been taken up in several villages around Lucknow.

The institute has also developed several patents and processes two of which relate to : (1) a process for separation and isolation of aromatic principles of Ambrette *(Abelmoschus moschatus)* seed, and (2) a new apparatus for distillation of perfumed water and 'attars', have been leased out for utilization.

Besides, several testing, evaluation and other facilities, also

provided by the institute, are : irradiation of plants and plant materials with gamma rays; plant identification; supply of plant material of economic value; estimation and analysis of plant material for proteins and amino-acids, oils and fats, active medicinal principles, gums and mucilages; pharmacognostic analysis of crude herbal drug formulations and facilities for scanning and transmission electron microscopy.

The regular publications brought out by the institute include : *NBRI News Letter* (quarterly); *Applied Botany Abstracts* (quarterly) and annual reports, besides current awareness services. Various other publications are also published from time to time.

As a part of public interaction, NBRI strives to create bio-aesthetic sense and gardenmindedness by arranging annual flower shows, short education-cum-training courses in cultivation and training of ornamentals, and by offering technical aid and advice on land-scaping, garden layout, dwarfing of plants and the latest techniques in horticultural practices. Training courses are also arranged in the area of plant tissue culture, floral crafts and standardization of indigenous formulations.

FIELD STATIONS

1. Banthra Research Station
   Banthra
   Dist. Lucknow
   Telephone : 50072

2. Usar Land Reclamation and
   Utilization Project
   House No. A 4/469
   Dodhpur, Aligarh
   Telephone : 6772

NATIONAL CHEMICAL LABORATORY (NCL)

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(Estd 1950)

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Telex: 0145-266

Director: Dr L.K. Doraiswamy, M.S. (Wisconsin), Ph.D. (Wisconsin), F.A.Sc., F.N.A., Hon. D.Sc. and Visiting Professor to University of Salford, UK, and University of Wisconsin, USA

A discipline-oriented laboratory, NCL is devoted to the advancement of chemical science and engineering. It aims at the optimum deployment of its resources between short-term problems of immediate relevance and long-term projects of national interest. Basic research, too, forms part of the overall programme of the laboratory and is encouraged to flourish vigorously.

The R&D work in NCL is carried out in eight divisions: (1) Biochemical Sciences, (2) Inorganic and Materials Chemistry, (3) Organic Chemistry (Agrochemicals), (4) Organic Chemistry (Drugs & Intermediates), (5) Polymer Chemistry, (6) Chemical Engineering, (7) Process Development, and (8) Physical and Structural Chemistry. A separate division of technical services looks after planning, co-ordination, evaluation, liaison and publicity. The research programmes of NCL are spread over ten areas, interdisciplinary approach being the corner-stone of NCL's research efforts.

NCL is among the pioneering institutes in the country to launch a fruitful and continuing programme of research in catalysis. The laboratory has developed a new class of zeolite catalysts and has christened them ENCILITES. They are capable of producing industrially important large-volume chemicals from crude oil based and other sources.

Among the catalytic processes developed at NCL, mention may be made of the vastly improved process for the isomerization of xylene. The catalyst ENCILITE-1 has been jointly developed by NCL and ACC, and has been successfully used by IPCL in its commercial reactor for obtaining a product rich in *o*- and *p*-xylenes. This marks the beginning of the high tech era in the chemical industry in India.

Drugs and drug intermediates constitute an important area of NCL's research activities. The main emphasis has been on new, innovative and economically attractive, synthetic routes for their manufacture. Recently NCL developed a process for making vitamin B_6 by a new and innovative approach. Its commercial production has been started by Lupin Laboratories Ltd, Bombay.

NCL also developed an innovative process for making Ibuprofen, an analgesic and anti-inflammatory drug. Work has been taken up on Pyrazinamide, Ciprofloxacin, Carbamazepine, Ambroxol and Phenylglycine Dane Salt on sponsorship basis.

Process development for Cephalosporins and their intermediates such as 7-ADCA is in progress. NCL is also working on the synthesis of anti-cancer drugs such as mitoxantrone and 4-demethoxydaunomycin.

In the area of agrochemicals some of the major technologies that have been commercialized are those for endosulfan, a highly effective organosulphur pesticide, dimethoate technical, a broad spectrum organophosphorus pesticide, and ethion, an organophosphorus insecticide/acaricide.

A relatively new development in the field has been the use of controlled release (CR) pesticide formulations. NCL has developed such formulations for carbofuran, a broad spectrum insecticide, and abate, a mosquito larvicide. CR formulations have much less toxicity than conventional formulations and hence reduce handling hazards.

The laboratory has undertaken work on the synthesis of commercially important synthetic pyrethroids, such as Alphamethrin, and their intermediates.

Jalshakti, a water absorbing polymer having the capacity to absorb 250-500 times its own weight of water, has been commercialized by Indian Organic Chemicals Ltd, Bombay. Because of its water retention capacity it has a high potential for application in wasteland development, oil seed missions, forestry, raising nursery beds and in transporting seedlings.

Research at NCL in the area of polymer science and engineering is aimed at producing new engineering plastics which can replace metals in specific applications; developing polymeric alloys by blending polymers; developing processes for making polymers from renewable resources; producing elastomers like sulphochlorinated polyethylene; and studying the

fundamental properties of polymers. NCL has undertaken a grant-in-aid project for developing light-weight durable polymers useful for physically handicapped people.

Among the processes released to industry are those for short shelf life adhesives and sealants, and liquid polysulphide rubbers. The basic technology for polyphenylene sulphide, a versatile engineering plastic, has been developed on laboratory scale. Another important project completed in this area is the development of drag reducers in oil transport.

NCL has an impressive record of achievements in the area of plant tissue culture (PTC). A notable first is the micropropagation of elite forest trees like teak and eucalyptus. The disease-free, high-yielding cardamom variety developed has shown great promise.

NCL has an agreement with the National Bank for Agriculture and Rural Development, according to which the PTC techniques developed for eucalyptus, bamboo and salvadora will be transferred to the users through an innovative mechanism. NCL, acting as the apex centre, will render technical advice to four state forest corporations and six user industries for establishing regional laboratories for raising plants and trees by tissue culture.

NCL has been widely recognized as an advanced centre of research. The conversion of cellulose to glucose and ethanol using immobilized enzymes, the production of biomass from cellulose, and the controlled release of pesticides by microencapsulation are being studied as part of a UNDP funded project. The Salford University, UK, has collaborated with NCL in the development of heat pumps. A study aimed at generating data for the design of slurry reactors is in progress in collaboration with the University of Erlangen, FRG. NCL is also collaborating with the Central Institute of Physical Chemistry of the East German Academy of Sciences in an investigation of the catalytic hydrogenation of carbon monoxide, preparation, characterization and application of ZSM-5 like catalysts.

NCL has a host of modern analytical and computational facilities. A sophisticated catalyst testing unit, installed some years back, is in regular use. NCL has a major share in the ownership of the ICL 1904S computer operated at the University of Poona. On its premises, NCL has an advanced Sn-23 computer system.

NCL acts as institutional consultant to various institutions

and chemical industries like the Ministry of Finance, Indian Petrochemicals Corporation Ltd and Indian Organic Chemicals Ltd. It is also collaborating in major projects with organizations like Engineers India Ltd, Delhi Cloth and General Mills and Rashtriya Chemicals and Fertilizers Ltd.

NCL scientists have received wide recognition from professional bodies for their work. The Homi J. Bhabha Award for research in applied sciences, VASVIK Industrial Research Award for outstanding research in the field of chemical sciences and technology, Herdillia Award for excellence in basic research in chemical engineering, Prof. Santappa Silver Jubilee Award in recognition of outstanding research in polymer science, and the K.G. Naik Gold Medal for outstanding contributions in the field of organic chemistry are some of the awards won by NCL scientists. Three scientists on the present staff have won the coveted Shanti Swarup Bhatnagar Award and four are Fellows of the Indian National Science Academy.

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE (NEERI)

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(Estd 1958)

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Director: Prof. P. Khanna

The significant R&D activities of the institute relate to: (1) Analytical techniques for precise quantification of pollutants in air, water, land and biological environment; (2) Cost-effective rural and urban water supply and sanitation systems; (3) Cost-effective technology for management of liquid and gaseous industrial effluents with emphasis on financially productive and indigenous resource-recycle and reuse systems; (4) Cost-effective control technology for management of urban and industrial solid wastes; (5) Environmental systems modelling to devise predictive tools for cause-effect correlationships; (6) Environmental systems optimization with a view to identifying functional and minimal cost solutions to environmental problems; (7) Environmental impact assessment of major developmental projects incorporating identification, prediction and evaluation of significant impacts on air, water, land, biological and socio-economic components of environment as also development of environmental management plans; (8) Environmental information and data base systems; (9) Framework for preventive environmental policy; and (10) Training packages for specific public and private sector undertakings.

The institute develops indigenous, cost-effective, financially-productive and easy to operate and maintain technology for pollution control systems thereby achieving polluter-acceptability to the environment preservation programmes in India. The R&D work conducted by the institute in the area of industrial pollution control has established that the investments in environmental management could indeed be paid back in 12 months to 6 years (depending on the industry) through recycling of wastes and byproduct recovery.

The institute has contributed significantly in meeting the national targets for International Drinking Water Supply

and Sanitation Decade Programme (1981-1990) by furnishing cost effective designs for urban and rural water supply and sanitation systems, evaluating designs prepared by other agencies, assessing existing systems with a view to reorganizing the same, and devising preventive maintenance strategies to conserve scarce potable water. The emphasis in R&D work has been on the synthesis of functional and minimal cost solutions to maximize service to the people in available financial and material resources with recourse to operations research tools.

The institute is also making significant contributions to societal missions of Government of India on Water Technology Mission (WTM) and Ganga Action Plan (GAP).

Its role in WTM relates to assessment of water quality in over 1500 problem villages in seven states; preparation of technology information packages on removal of fluorides, iron, turbidity, and bacteriological contamination; treatability studies to assess minimal-cost water purification requirements; establishment of six demonstration plants in three states; organization of national camps on water purification processes; and preparation of audiovisual aids for effective dissemination of cost effective technologies to state officials and the beneficiaries in problem villages.

The role of the institute in the GAP relates to the preparation of action plan for solid waste management at Varanasi; design of wastewater collection, transportation, treatment and resource recovery systems in three towns of Bihar; design of intermediate sanitation options in identified locations in Bihar; evaluation of existing municipal wastewater treatment plants at Patna with a view to optimizing their performance; water quality monitoring and modelling in estuarine region; conducting of training programmes for middle level engineers from the three states involved in GAP; preparation of guidelines for the establishment of an institute for training of operation and maintenance staff in GAP-supported wastewater management systems; and devising and validating frameworks for engineering evaluation and environmental impact assessment of investments being made by Government of India in GAP.

One of the pioneering activities of the institute relates to environmental impact assessment of major developmental projects thereby internalizing environmental concerns in the

process of economic development. The emphasis is on quantification of favourable and adverse impacts of the project on air, water, land, biological and socio-economic components of environment to facilitate objective decision-making on alternative routes for development, process technologies and project sites. The sectors covered so far under this activity include petroleum, coal, fertilizer, thermal power plants and port trusts. The institute has also developed technology ranking matrices for gaseous, liquid and solid waste management systems to ensure polluter participation in the decision making process. It has also contributed significantly to the process of establishment of effluent standards for gaseous and liquid wastes in India. A case in point is the Minimal National Standards (MINAS) for smaller paper and pulp mills.

NEERI has several international collaborations in emerging areas of environmental management. Some of the current R&D programmes of the institute relate to management of recalcitrant and hazardous wastes; risk assessment associated with industrial development projects; development of indigenous and cost effective catalytic converters for the control of noxious automobile emissions; development of indigenous ambient and source air and water pollutant analyzers; basic research on assimilative capacity of environment; computer-model for an ecologically and economically self-sufficient village unit; computer-aided environmental impact assessment; and delineation of an anticipatory-preventive environmental policy framework as an instrument for ushering in ecological modernization.

The R&D endeavour of the institute in pollution control encompasses the entire spectrum of industry sectors in the country. The institute had R&D programmes on integrated pollution control systems with a view to identifying permissible dispersal of pollutants (from health, environment and aesthetic considerations) in air, water, and land components of environment prior to the enactment of Environmental Protection Act (EPA) in 1986. Another ongoing research interest of the institute in this direction is addressed to the conceptualization and delineation of a preventive environment policy framework that, when developed by the institute through an inter-institutional endeavour and adopted by the Government of India, would benefit both ecology and

economics through prudent usage of resources and maximization of economic productivity.

The institute has been a pioneer in the assessment of air quality in ambient environment in ten large and medium-sized cities in the country over a decade (1976-86); preparation of computerized air quality database; and estimation of assimilative capacity of air environment in areas adjoining highly polluting industries and metropolitan regions through its WHO-UNEP collaborated National Air Quality Monitoring Programme. These activities have led to the establishment of ambient air quality trends, emission inventories for a range of industries, and delineation of air quality management strategies in India with a judicious trade-off between the cost of air pollution control and damage function occurring due to health, vegetation, material and aesthetic impairments.

A significant contribution of the institute in air quality management relates to the study at Agra with special reference to the impacts of Mathura Refinery and foundries on air quality with a view to devising strategies for preserving the beauty of the Taj Mahal.

The institute has been involved in over 110 specific industry related studies during the last decade on the assessment of pollution loads including fugitive emissions, establishment of mitigation measures with cost-benefit considerations, and delineation of industry specific air pollution management programmes in steel, coal, petrochemicals, ores and alloys, photofilms, drugs, chemicals, fertilizer, thermal power, cement, paper, textiles, and pharmaceuticals sectors.

A major contribution of the institute relates to the development of indigenous control technology packages for important small scale industry sectors like foundry, dairy, sugar, textile, printing press, chemicals, rubber, pottery, stone crusher and brick-kiln. The emphasis is on resource recovery and reuse facilitating financial gains to the polluter through pollution control.

The current R&D interests of the institute relate to development of indigenous, inexpensive, lead and sulphur resistant, three-way catalytic converter for the control of noxious automobile emissions; development of indigenous, microprocessor-based ambient and source monitoring and control equipment; and delineation of plant pollution-attenuation

factor with a view to quantifying optimum size of the green belts around air-polluting industries.

The institute has been engaged, since its inception, in identifying and conducting research on priority areas of water pollution control; monitoring ambient water quality; designing indigenous, low cost and energy efficient industrial wastewater treatment systems; and devising strategies for water quality management in India.

The institute has contributed significantly to the establishment of ambient water quality standards as also the effluent standards for discharge of wastewater into sewers, fresh and coastal water bodies, and on land for agencies like the Bureau of Indian Standards (the erstwhile Indian Standards Institution) and Central Pollution Control Board. One of the recently concluded activities on the subject relates to the preparation of Comprehensive Industry Document for Small Pulp and Paper Mills facilitating establishment of Minimal National Standards (MINAS) with due consideration to techno-economic feasibility of various treatment options.

NEERI has developed design criteria for a series of low-cost wastewater treatment systems, viz. stabilization ponds, oxidation ditch, carrousal ditch, anaerobic and aerobic lagoons, and anaerobic and aerobic fixed film reactors, aquaculture, and agriculture that exploit the advantages of generous sunshine, high temperatures and agriculture land use in the country.

In view of the constraints faced by the industry in metropolitan cities with respect to the high cost of treatment through conventional biological routes, high space requirements for conventional treatment systems, and non-availability of adequate quantity of process water in summer to sustain production, the institute has devised financially productive physico-chemical treatment routes for resolving the aforementioned constrains after detailed studies and cost-benefit analyses of such processes as equalization, neutralization, dissolved air floatation acetate and nitrate membranes, chemical coagulation, adsorption, filtration, and ion-exchange.

One of the current areas of R&D relates to the management of recalcitrant and hazardous wastes through biotechnological routes. Specific microbial strains have been isolated and mass cultured for cost effective treatment of efflu-

ents bearing high concentrations of phenols, cyanides, aromatics and other recalcitrant multi-substrates. These researches have resulted in the design of functional wastewater treatment systems for low temperature carbonization coal and coke oven plants, sodium cyanide, organic chemical, synthetic drug, photofilm, opium and alkaloid, and phenol-formaldehyde resin manufacturing industrial units Work is being pursued on molten salt combustion and molten glass incineration systems for safe disposal of highly hazardous wastewaters.

Significant R&D work has also been carried out on resource recovery from organic wastes from such industrial units as distilleries, breweries and food-processing; and from small communities and squatter settlements that invariably emerge in the vicinity of large industrial establishments. The focus has been on the generation of fuel, fertilizer, fibre, food, and fodder through cost-effective and energy-efficient anaerobic and aerobic treatment processes as also through aquaculture and agriculture. The institute has also been involved, in the design of industrial wastewater management systems in over 300 units in the steel, fertilizer, petrochemicals, pesticides, pharmaceuticals, inorganic and organic chemicals, paper, textile, tanning, sugar, and milk sectors. The institute has been engaged as a consultant by the Ganga Project Directorate for the Institute for Training of Operation and Maintenance staff.

NEERI has carried out significant R&D work on treatment, recovery and disposal of industrial sludges and recycle of industrial and municipal wastewater on land. The sectors covered so far in sludge utilization studies include fertilizers, organic chemicals, textiles and thermal power plants The investigations include assessment of impacts of leachates from industrial sludges on surface and groundwater quality. It has developed guidelines for recycling of wastewaters through crop irrigation with concomitant waste nutrient utilization from dairy, sugar, food processing, paper, and textile industries as also untreated, partially treated, and diluted municipal wastewaters.

The municipal solid waste problem has been analyzed in over 45 cities with a view to devising cost-effective strategies for management including storage, collection, transportation, and disposal/resource recovery systems through com

posting, anaerobic digestion and pyrolysis with comprehensive cost-benefit analysis. A computer-based optimization algorithm has been developed for vehicle routing problem and is presently engaged in the larger exercise of devising computer-aided algorithm for minimal cost solution to the total solid waste management problem in metropolitan cities.

The current endeavour of the institute in land quality management relates to the preparation of three dimensional matrices covering soil, plant and wastewater subsystems with a view to delineating guidelines for land application of wastewaters and sludges based on over fifteen years of its R&D on the subject.

The institute has conducted environmental impact assessment (EIA) of projects in thermal power and port trust sectors and is presently engaged in EIA of industrial projects in petroleum, coal and fertilizer sectors.

Recognizing that the Government of India has made EIA mandatory for all major developmental projects, work is being pursued with a view to developing a computer-aided methodology for EIA relevant to industrial projects in India with due consideration of constraints on limited expertise, resources and database. The research incorporates screening and scoping criteria; identification of significant impacts through networks on air, water, land, biological and socio-economic component of environment; prediction of significant impacts through mathematical and simulation modelling; evaluation of impacts through Batelle Environmental Evaluation System and UNEP Benefit-Cost Test Model; and preparation of environment management plans in collaboration with the Ministry of Environment and Forests. This research would enable the ministry to draw precise guidelines for the benefit of industrial project proponents.

NEERI is also engaged in information dissemination through research publications and training programmes. The publications include an in-house research journal, technology information packages, technical digests, newsletters, and a host of popular articles and audiovisual aids for information dissemination.

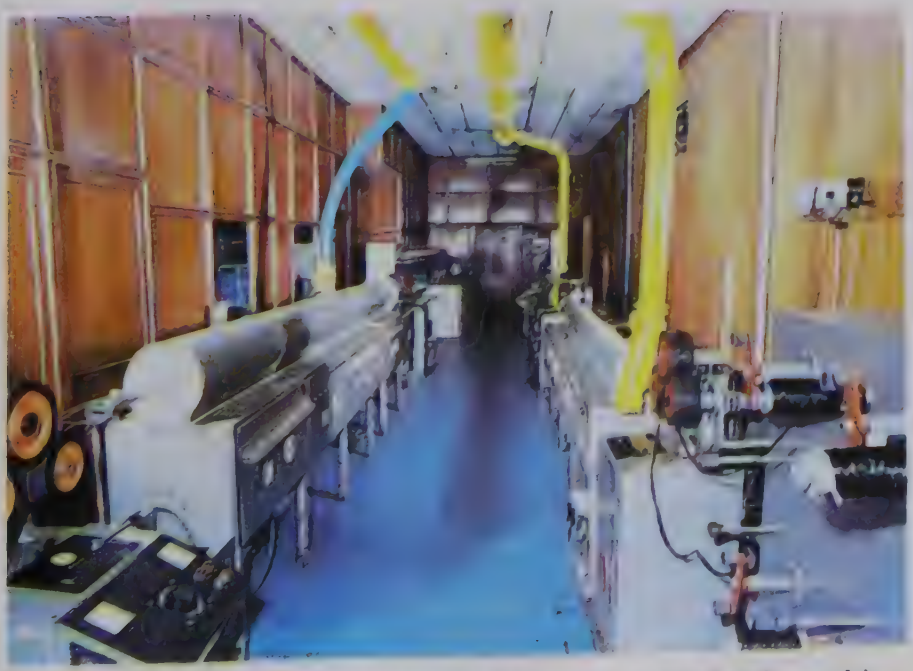
The institute is collaborating centre/nodal agency in international environmental information networks credited to WHO, UNEP, WRC, EPA, ENSIC, APTIC, SWIRS and

Helicopter-borne magnetic survey in Antarctica carried out by NGRI in January-February 1988 around Dakshin Gangotri, using a Chetak helicopter of Indian Navy

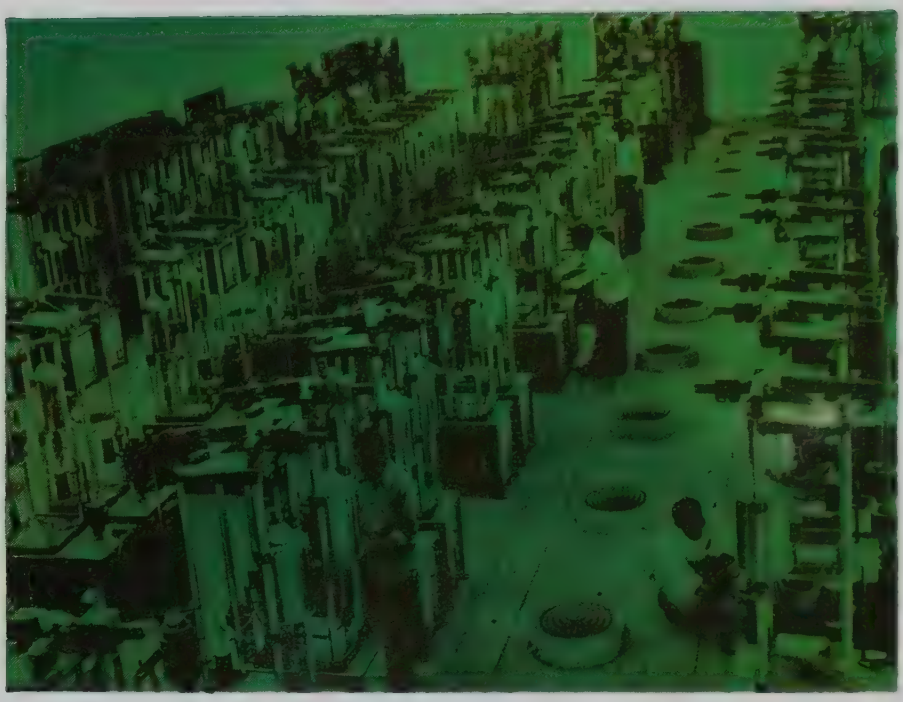
Direct reading current meter developed at NIO, Goa

Green mussel culture on floating raft; technique developed at NIO, Goa

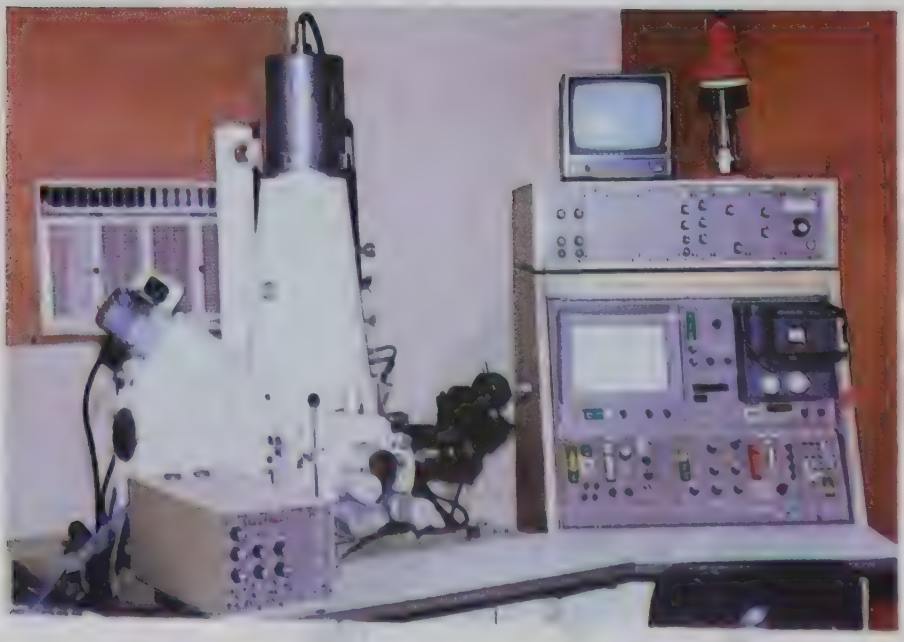
Prototype of xero-radiograpy machine developed at NPL, New Delhi for field trials at AIIMS, New Delhi



Experimental pilot plant designed by NPL, New Delhi, for making high performance continuous carbon fibres



A view of the battery of creep testing machines at NML, Jamshedpur



Scanning electron microscope at RRL, Bhopal

CEPIS. It offers a package of twelve training programmes every year related to various facets of enviornmental management. Custom-made industry-specific training programmes are also organized on request from specific sectors. International agencies like DANIDA, DATA and WHO collaborate with the institute in organizing regional (South-East Asia) training programmes.

ZONAL LABORATORIES

1. NEERI Ahmedabad Zonal Laboratory
Sub-urban Sub-Pumping Station
Beyond Calico Mills
Sewage Farm Road
Ahmedabad 380022 (Gujarat)
Telegram NEERI, Ahmedabad-22
Telephone: 391300

2. NEERI Bombay Zonal Laboratory
89-B, Dr Annie Besant Road
Worli, Bombay 400008 (Maharashtra)
Telephone: 4936635
Telex: 011-75462

3 NEERI Calcutta Zonal Laboratory
23, R.N. Mukherjee Road
Calcutta 700001 (West Bengal)
Telegram NEERI, Calcutta
Telephone: 238792

4. NEERI Cochin Zonal Laboratory
'Maitri' No. 33/24-A
Chakkungal Road, Palarivattom
P O Cochin 682025 (Kerala)
Telegram NEERI, Ernakulam
Telephone: 84788

5. NEERI Delhi Zonal Laboratory
Chandrawal Waterworks No. II
Lala Shamnath Marg
Delhi 110054
Telegram: DELPHERI, Delhi-54
Telephone: 2522866

6. NEERI Hyderabad Zonal Laboratory
RRL Campus
Hyderabad 500009 (Andhra Pradesh)
Telegram: NEERI, Hyderabad-9
Telephone: 850549
Telex 155-261 (RRL, Hyderabad)

7. NEERI Jaipur Zonal Laboratory
A-11, Mahavir Udyan Path
Bajaj Nagar
Jaipur 302077 (Rajasthan)
Telegram: NEERI, Jaipur-77
Telephone: 74782

8 NEERI Kanpur Zonal Laboratory
6/33, Civil Lines
Kanpur 208002 (Uttar Pradesh)
Telegram NEERI, Kanpur-2
Telephone: 40127

9 NEERI Madras Zonal Laboratory
CSIR Complex, TTTI
Taramani P.O.
Madras 600113 (Tamilnadu)
Telegram CONSEARCH, Madras
Telephone: 413964
Telex: 041-362 (CSIR Complex)

NATIONAL GEOPHYSICAL RESEARCH INSTITUTE (NGRI)

Hyderabad 500007
(Estd 1961)

Telegram: GEOPHYSICS

Telephones. 850141. 851124
Telex: 0425-7018

Director: Prof. Vinod K. Gaur, Ph.D. (Lond.), F.N.A., F.A.Sc.

The basic objective of researches at the institute is to define with increasing precision, the earth structure and processes on all scales—from planetary to mineral grain proportions and from its nebulous beginnings to the present day. Its immediate goals are to map extraordinary features at different depths within the earth, which represent departures from the usual homogeneous conditions. For, these inhomogeneities and special structures provide information about the manner and time of their origin, which allows the study of the earth's behaviour under varying conditions of its evolutionary history. Some of these inhomogeneities which are within the first few kilometres of the earth's surface are of particular concern to mankind as they may contain valuable concentrations of mineral resources, or may prove to be sites of instability, or weakness. Major research endeavours of the institute are therefore directed towards continually improving our capabilities to determine such inner structures of the earth at different depths with increasing resolution and accuracy, and to improve our understanding of the evolution of the earth through the study of the nature, location, environment and time of occurrence of such inhomogeneities. These, in turn, involve a chain of research programmes aimed at developing: (i) sensing methods/systems of increasing range and sensitivity to discern the nature of buried inhomogeneities, (ii) signal abstraction methodologies to extract weak signals out of background noise, (iii) conceptual and numerical frameworks for modelling the form and character of physical processes, such as rock failure and fluid transport in rocks, as well as those of buried target inhomogeneities, with as much detail as possible.

The strategy adopted for accomplishing this objective is to advance, through a set of interrelated programmes, national capabilities in: (a) deep exploration of the lithosphere, and de-

termination of the possible physical and chemical structure of the lithosphere and the subjacent mantle in an evolutionary context, (b) high resolution prospecting of near surface resources, and (c) delineating and monitoring significant parameters of some of the earth's hazard prone systems, notably of groundwater regimes, rock bursts and earthquakes, which would enhance our ability to predict their future states and thereby to design appropriate remedial measures.

Additionally, the institute makes endeavours to seek out and solve immediate and emerging problems of national concern, by innovative applications of the available knowledge and expertise constantly enriched by new research findings, through research programmes sponsored by industry. These problems are selected by keeping in view the imperatives of social need and the possibility they offer of further enhancing knowledge and expertise. Important sponsored research activities thus have a synergistic relationship with the institute's R&D work and include such programmes as deep seismic sounding, fixed wing aircraft and helicopter borne magnetic and time-domain electromagnetic exploration in difficult environments, high resolution seismic exploration for mapping details of subsurface structures in complex situation, study of rock bursts in mines, earthquake hazard assessment, and exploration, assessment and management of groundwater in scarce and threatened terrains.

Deep Seismic Sounding (DSS) studies, started in India by NGRI in 1972 as a joint venture with the Institute of Geophysics, Kiev, USSR, have now expanded into a major project under which a large number of long DSS profiles in different parts of the Indian continental crust have been made. These profiles provide a cross section of the ground in terms of layers having different elastic wave propagation velocities up to, and somewhat beyond, the bottom of the continental crust, which is 30 or more kilometres deep in most continents of the world. The shallower part of the cross section thus obtained gives information about buried sedimentary basins and the structure of the formations above the hard rock basement. A significant part of these continuing studies is financially supported by the oil industry in view of the importance of the findings of DSS in connection with the search for petroleum.

In the field of Exploration Geophysics, the development of field geophysical instruments goes hand in hand with research

in computer modelling and interpretation techniques. Programmes on delineating shallow structural features by using seismic shear waves, and the use of pseudo-random excitation for microprocessor-based measurement of complex resistivity, are examples of new directions in geophysical instrumentation. Development of numerical models, and computer software for the solution of geophysical inverse problems form important components of this work.

Application of scientific methods for the location of water wells, specially in the hard rock areas, reduces the possibilities of failure. As part of the work of the ongoing Technology Mission on Drinking Water in problem villages of the country, NGRI is applying geohydrological and geophysical techniques for the location of potential borewell sites in several hundred villages. In the field of geohydrology estimation of aquifer parameters through modelling and the use of tracer techniques, evaluation of annual recharge, and the study of the disposition and dynamics of the interface between saline and fresh water in the coastal areas are some of the ongoing activities.

The study of the propagation of elastic waves in the earth created by earthquakes has provided the most important large scale information about the interior of the earth known today. One of the new approaches for such studies uses tomographic construction of an image of the inside of the earth by studying the surface vibrations caused by many earthquakes. NGRI has embarked on such seismic tomography for the study of the deeper regions below the Indian continental crust. Study of the physics of earthquake processes in the highly seismic belt in the northeastern region of the country is being done in collaboration with the Regional Research Laboratory, Jorhat. A network of movable observatories has been collecting microearthquake data for analysis and interpretation. One of the objectives of this work is to analyze the microearthquake data in real time in order to find out possible parameters for the prediction of large catastrophic events. Microearthquakes associated with a number of large water reservoirs of the country are being monitored in connection with the study of the physical processes that occasionally lead to earthquakes in large artificial reservoirs.

Measurement of underground ambient stress in the rocks is more difficult than the measurement of deformations or vibrations. A facility for the measurement of *in situ* stress in rocks along a drill hole has been established. This system sets up in-

duced fractures in the rock by pumping water in a confined zone in order to determine the actual ambient stresses. A quantitative characterization of the stress regime of the subcontinent is being attempted by making measurements in boreholes at different points.

In collaboration with the National Institute of Oceanography, Goa, NGRI is engaged in the geophysical study of the Indian Ocean lithosphere. Using the available national facilities for expeditions with ocean going research vessels, shipborne gravity, magnetic and bathymetric data along selected profiles are being collected and analyzed. NGRI has also participated in five of the six expeditions to Antarctica till 1987 for the collection of geophysical data around the Indian station *Dakshin Gangotri* as well as in the Schirmacher Oasis area. During the 1987-88 expedition aeromagnetic survey of a large area was carried out using a helicopter of the Indian Navy, with a doppler navigation system and a proton precession magnetometer.

The institute has established a number of high technology facilities. It has computer controlled analytical systems such as electron probe and X-ray fluorescence analyzers, a sophisticated mass spectrometer for Rb-Sr geochronology, apparatus for the measurement of rock radioactivity and rock magnetization, for the accurate estimation of very small proportions of tritium in water, of ^{14}C in samples, $^{18}O/^{16}O$, and for the measurement of some physical properties of rocks under high pressure. An Inductively Coupled Plasma (ICP) analyzer that will substantially speed up elemental analysis of rocks is being installed.

A seismological observatory and a geomagnetic observatory have been running in the campus of the institute for many years. There is also a geomagnetic-cum-earth current pulsation observatory at Choutuppal near Hyderabad, and an equatorial magnetic and micropulsation observatory at Ettaiyapuram in Tamilnadu. These observatories routinely produce data which are exchanged internationally.

The institute's library houses more than 240 scientific journals, 9,000 bound volumes and 14,000 books. NGRI publishes a quarterly entitled *Geophysical Research Bulletin*.

The future plans of work of the institute include geodetic very long baseline interferometry for the measurement of continental plate movements, wide ranging seismic tomography including cross-hole tomography, deep time domain electro-

magnetics, and studies in high pressure rheology and mineral physics. A Cyber computer system is being added with funding from the Oil Industries Development Board. This will help all computation-intensive programmes, such as computer aided pattern recognition, and development of seismic software and interpretation tools, in addition to speeding up all other computerized activities.

NATIONAL INSTITUTE OF OCEANOGRAPHY (NIO)

P.O. NIO, Dona Paula (Goa) 403004
(Estd 1966)

Telegram: OCEANOLOGY, PANAJI

Telephones: 6253, 6254, 6255, 6256 & 5988 (Panaji Exch.)
Telex: 0194.216 NIO IN
0194.316 MG IN

Director: Dr B.N. Desai, M.Sc., Ph.D., F.N.A.Sc.

The main objectives of the institute are to explore both living and non-living resources in the seas around India and to develop technology for the exploitation of resources from the sea. The institute aims to be a focal point for the oceanographic data and information pertaining to the Indian Ocean. The institute actively participates in the national programmes on Antarctic research and exploration of the seabed minerals. Apart from its in-house R&D projects, the institute also undertakes sponsored work and offers consultancy services on problems connected with the sea.

The R&D activities of the institute are carried out by the following divisions/sections: (1) Physical oceanography; (2) Chemical oceanography; (3) Biological oceanography; (4) Geological oceanography; (5) Ocean engineering; (6) Data and Information; (7) Publication and Reprography; (8) Marine instrumentation and Computer; (9) Biofouling and Corrosion and (10) Training. The institute has three regional centres one each at Bombay, Cochin and Waltair. It has its own research vessel *Gaveshani*. Also, it has been entrusted with the scientific management of ORV *Sagar Kanya* which is one of the most sophisticated research vessels in the world today and owned by the Department of Ocean Development.

With the emergence of a new ocean regime, India has an Exclusive Economic Zone of 2 million sq. km., covering an area extending up to 200 nautical miles from the shoreline. Intensive exploration of the EEZ has been identified as a thrust area in oceanography for the rest of the seventh plan period and R&D programmes have been reoriented in this direction.

Survey of marine living resources, location of new fishing grounds, and development of culture techniques for prawns,

molluscs and seaweeds are important aspects of NIO's research to generate extra seafood. A technique for culturing green mussels has been successfully developed and the know-how has been transferred to fish farmers of Goa through demonstrations. Biological processes, responsible for production of living matter are studied with respect to space and time, and with special reference to the effects of natural and man made changes in the marine environment.

The institute conducts various geological and geophysical investigations in the nearshore, continental shelf, offshore and deep sea areas for exploration of minerals. These investigations have resulted in the location of polymetallic nodules and ilmenite placers, and preparation of geomorphological and sedimentological maps. Precise and accurate underwater surveys are undertaken through side scan sonar, seismics and underwater photography. An area of about 4 million sq. km in the Central Indian Ocean was surveyed for polymetallic nodules. This work led India to become the first country in the world to get registration as a 'Pioneer Investor' at the UN Preparatory Commission for the International Sea-bed Authority and allocation of an area of 150,000 sq. km with exclusive mining rights.

Identification of marine plants and animals which are sources of organic chemicals and drugs forms an important project of the institute. Extracts of 142 marine plants and animals have been prepared and many of them have shown promising pharmaceutical properties. The chemistry division is working on the distribution of important nutrients and trace elements in the seawater and other chemical parameters which are the limiting factors for the biological production in the sea.

In the multi-disciplinary project on protection of marine environment, studies are conducted on the identification and monitoring of the various pollutants, source of pollution and its effects on marine life to evolve protection measures and to locate suitable sites for the safe disposal of industrial and domestic effluents. Several agencies have been benefitted by such studies.

The physical oceanographic studies include physical processes occurring in the sea, land-sea and air-sea interactions and upwelling. The air-sea interaction programme aims at understanding the generation, growth and decay of the monsoon system and the tropical cyclones. The institute has participated in Monsoon Experiment programmes and collected valuable

data from the Arabian Sea and the Bay of Bengal. Studies on storm surges along the Indian coasts and ocean dynamic modelling are also carried out.

Remote sensing of oceanic parameters through satellites is a new venture undertaken by the institute with the assistance of UNDP. The remote sensing techniques would facilitate better understanding of weather systems, exploitation of marine resources, pollution monitoring and information on ship routing.

The marine instrumentation programme includes design, development and fabrication of oceanograpic instruments, particularly those based on microprocessor systems. An automatic weather monitoring system developed in the institute was installed at Antarctica during India's first expedition. The institute's computer centre has ND-520 Super mini computer and several other desk top systems.

The biofouling and corrosion investigations are aimed at studying fouling, wood destruction and corrosion in the inshore and offshore waters.

The institute conducts advanced training courses in different disciplines of oceanography including ship board training to create trained manpower.

The Indian National Oceanographic Data Centre of the institute is a national centre for acquiring, processing, storing and disseminating oceanographic data and information pertaining to the Indian Ocean. It also maintains liaison with the world oceanographic data centres. The institute has a well equipped library which receives about 380 research journals, covering the various aspects of marine science.

The regional centre at Bombay carries out oceanographic studies with emphasis on pollution control, particularly in the coastal areas of Gujarat and Maharashtra. The work includes identification of sites in the sea estuaries for the disposal of sewage and industrial wastes.

The regional centre at Cochin is a depository centre for zooplankton samples collected during the International Indian Ocean Expedition. This centre is now engaged in the studies on ecology of Kerala backwaters, some aspects of pollution, acquaculture, coastal erosion and nearshore circulation along the south-west coast of India. As a part of the programme, the regional centre has developed and improved the traditional prawn culture techniques.

The regional centre at Waltair is engaged in multidisciplinary work in marine science with special emphasis on the geophysical studies of the sea off Waltair and the adjacent areas of the east coast of India.

The institute caters to the needs of several agencies by providing sponsored/consultancy services for pipeline surveys, harbour development, pollution control, resource surveys and coastal zone management.

The institute is also involved in projects which receive assistance from international agencies such as UNEP, UNDP, Intergovernmental Oceanographic Commission and UNESCO.

The Publication Section brings out the following publications: *Mahasagar*—bulletin of the National Institute of Oceanography (quarterly), *NIO Newsletter* (quarterly), *Collected Reprints* (collection of research papers published by the NIO staff) (annually), and annual reports.

REGIONAL CENTRES

1. NIO Regional Centre
   Pullepady Cross Road
   Post Box No. 1913
   Cochin 682018
   Telegram: OCEANOLOGY, Cochin
   Telephones: 360306 & 369384

2. NIO Regional Centre
   Sea Shell Building
   Seven Bungalows
   Versova
   Bombay 400061
   Telegram: OCEANOLOGY, Bombay
   Telephones: 574807 & 573662
   Telex: 011-71182 NIO B

3. NIO Regional Centre
   8-1-70, Bonanza
   Peda Waltair
   Visakhapatnam 530017
   Telegram: OSTECHLAB, Waltair
   Telephones: 64634 & 63992

NATIONAL INSTITUTE OF SCIENCE, TECHNOLOGY AND DEVELOPMENT STUDIES (NISTADS)

Hillside Road, New Delhi 110012
(Estd 1980)

Telegram: NISTADS

Telephones. 5714064. 583227
Telex: 031-61187 NSTD IN

Director: Dr Ashok Jain. M.Sc., Ph.D.

The activities of NISTADS are aimed at : (1) Generating information, knowledge and expertise in the field of science and technology policy by undertaking studies on the social processes of the growth of S&T with a view to assisting the policy makers in designing the development process; (2) Helping in formulating and evaluating appropriate planning and management systems in S&T units and organizations through studies and action research on techniques and methods with a view to improving the effectiveness of R&D organizations at national, agency and institutional levels; (3) Building up a stock of basic knowledge on the process of development of science and technology with their historical, social, economic, political, cultural, ethical and philosophical dimensions; (4) Undertaking research, training, consultancy and sponsored projects with other countries on matters of specific interest to CSIR, government departments, universities, industries and national/international science policy making bodies, and strengthening the professional collaborative effort; (5) Studying science policy organizational and management of R&D systems of other countries in order to bring in an interface with the national science policy; (6) Organizing training programmes in S&T policy and R&D management with a view to inculcating professionalism in science, and communicating the research results for the improvement/efficiency in organizational system of R&D; (7) Developing studies and action research on the choice/adaptation/generation/transfer of appropriate technology for artisans and craftmen; and (8) Forecasting future trends of research in S&T, and identifying the areas of technologies needing new thrust.

The institute has a multidisciplinary approach and it car-

ries out its research through the study of national and international published work, archives, government and other corporate documents; field visits/studies; administration of questionnaires; and personal interviews; and by involving eminent personalities from government departments, institutions, industry, etc.

NISTADS's current research projects are grouped in the following divisions: (1) Planning, Organization and Management of Science and Technology; (2) S&T Indicators for Development; (3) Technology Absorption, Assessment and Industrial Development; (4) Social Relations of S&T; (5) International S&T Studies; (6) International Technology Transfer; (7) Technology Forecasting and (8) History, Philosophy and Theory of Science.

With a view to developing an information infrastructure covering the trends and growth of science and technology fields like S&T policy and management and the broader social, economic, political, cultural and ethical aspects of S&T, especially for developing countries, a computerized information system/database is being established at NISTADS.

The institute organizes training programmes for the administrative and scientific personnel of CSIR research laboratories in the areas of (a) R&D Management, (b) Project Management, (c) Administrative Management, (d) Materials Management and (e) Financial Management including project budgeting and costing. Each training programme is tailor made to suit the requirements of the recipient group.

NISTADS organizes colloquia, seminars, workshops and conferences on special topics of its concern. In addition to publishing research papers, project reports, monographs and proceedings to disseminate the results of its researches, the institute brings out a monthly journal, *Current Literature on Science of Science* (CLOSS), which includes in it abstracts, digests, reviews of curent science policy literature from Indian and foreign journals, statistics, news and notes etc.

The institute's library currently has nearly 8000 books, 6000 reports, 2500 reprints of papers, and regularly receives nearly 250 journals from all over the world (of which 12 serials are received against subscription and the rest on exchange/complimentary basis). Facilities are provided to scholars from developing countries to work at NISTADS.

The institute has an Alpha 1042E computer system with 1MB memory. 180 MB hard disk, 11 terminals and a few PC/ATs and PC/XTs. The computer facility is utilized for developing databases on current literature of science of science and archival resources of S&T, and statistical analysis. The institute also has Wang WP/30 word processing system which is extensively used to bring out the publications of the institute.

NATIONAL METALLURGICAL LABORATORY

P.O. Burmamines, Jamshedpur 831007
(Estd 1950)

Telegram: METALS, Tatanagar Telephones: 24281 & PBX 26901-7
Telex: 0626-210

Director: Dr S. Banerjee

The objective of the laboratory is to undertake research and development work in various disciplines of metallurgy and allied fields. The laboratory is well equipped to carry out on an organized basis, research, development, investigation and testing work on ores, minerals, refractories and ferrous and non-ferrous metals and alloys. The R&D activities of the laboratory are so oriented as to provide solution to diverse problems of universal and metallurgical based industries in the country. Stress is laid on large scale and inplant trials to develop processes and products up to the stage of market acceptability and technology transfer for commercial implementation. Fundamental research is undertaken as a back-up to the applied work.

The laboratory's R&D efforts on the utilization of indigenous resources and talents have materialized in fruitful results culminating in the establishment of a number of industrial units and in the transfer of technology to units already established. The laboratory is actively collaborating with R&D organizations both in public and private sector. It enjoys a high reputation in the metallurgical world and there is hardly any agency in India which has not availed the laboratory's expertise and facilities related to treatment of low grade ores and minerals, agglomeration of fines, development of high temperature steels, creep testing, analysis of metallurgical service failures of vital engineering components of power plants, etc.

The work of the laboratory has been reorganized in the following divisions: Mineral Processing, Non-ferrous Processing, Ferrous Processing, Material Processing, Material Evaluation, Process & Project Engineering, Corrosion Protection, Refractories Technology, Analytical Chemistry, Computer Application, Instrumentation & Electronics, Construction & Maintenance Services, Research Management, Finance & Accounts and Administration.

The laboratory has established a number of large scale faci-

lities for development work and for studying the techno-economic feasibility of the processes. These include: a 210-test-point creep testing facility with UNDP assistance; an integrated mineral processing unit which can treat up to 5 tonnes of ore per hour; a 500 kVA submerged arc smelting furnace for production of ferroalloys; facilities for production of iron and steel by non-conventional methods; dense carbon aggregate for production of soderberg paste and other carbon refractories and pilot plants for production of electrolytic manganese metal and electrolytic manganese dioxide and also a pilot plant for producing 1 tonne/day sponge iron by vertical retort furnace. Besides these, the laboratory has many sophisticated facilities such as X-ray fluorescence spectrometer, atomic absorption spectrophotometer, computer based direct reading spectrometer, image analyzer system and X-ray defractometer, acoustic emission unit, transmission electron microscope, ENCORE supermision computer with two nodes (4MB & 2MB) and 7 terminals, one graphic computer (1MB) and eight personal computers.

NML's expertise is utilized by industrial and other organizations both at national and international level. The laboratory acts as a consultant to many public and private sector metallurgical and engineering industries and collaborates in solving their problems associated with trouble shooting operations, increasing production, improving efficiency, etc. It also works in close association with the consultancy engineering firms like Metallurgical & Engineering Consultants (India) Ltd (MECON) and Engineers India Ltd with a view to offering package deals.

The laboratory's efforts in ore-dressing and mineral beneficiation have resulted in the commissioning of many commerical plants in the country. The 6000 tonnes/day Malanjkhand copper concentrator, dedicated to the nation by the then Prime Minister, Shrimati Indira Gandhi on 12 November 1982, is based on the investigations made at NML. The flowsheet evolved by NML was finalized with the approval of Soviet Project consultants who also reported similar findings and the NML recommendations were accepted in toto Based on investigations conducted and the flowsheets developed by NML, plants have been established for: iron ore washing at Barsua, Bailadila; sintering at Rourkela, Bhilai, Durgapur and Tisco; and graphite beneficiation at Titilagarh. Consultancy services

have been provided to Gujarat Mineral Development Corporation in setting up a 500 tonnes/day fluorspar beneficiation plant; and to Hindustan Copper Ltd for its 1000 tonnes/day Rakha Copper Project.

The laboratory's expertise has been utilized in setting up a fluorspar beneficiation plant at Chandidungri by Madhya Pradesh and Maharashtra Minerals & Chemicals Ltd

Another notable contribution of the laboratory in the field of mineral conservation is the beneficiation of coal middlings and rejects through froth flotation, bringing down the ash content. It is being implemented by the CMPDI, Ranchi The coal fine concentrate thus produced can be used in thermal power plants, steel plants, etc.

The overseas assignments that have been successfully completed by the laboratory relate to the investigations sponsored by UNIDO on Aswan iron ore for setting up an iron and steel plant in Egypt and by Nepal Bureau of Mines for setting up an iron and steel plant utilizing their own resources. The investigations sponsored by the Government of Syria through MECON, for setting up a steel plant based on their iron and other raw meterials have also been completed.

NML has developed the vertical retort route for the direct reduction of iron ores under Indian conditions. Commercialization of the vertical retort technology for production of sponge iron using non-coking coal is in progress with active collaboration of MECON. Simultaneously, the know-how for efficiently melting the sponge iron in electric arc furnace has also been developed.

Currently, NML has developed, in collaboration with SAIL, R&D Centre for Iron & Steel, Ranchi, a technology for substituting steel scrap with direct reduced iron in LD & BOF Another significant achievement is the development of technique for production of low and extra low S & P molten iron by using sponge iron in submerged arc furnace popularly known as VRDR-SAF process. Polymetallic sea nodules which are potential source of non-ferrous metals particularly copper, nickel, cobalt and manganese, are being extracted at NML by reduction roasting-ammonia leaching-solvent extraction-electrowinning process, under a project sponsored by Department of Ocean Development Soft spheroidal graphite and compacted graphite cast iron have been produced making use of sponge iron fines using a pure magnesium plunging technique Shape

memory alloy based on Cu-Zn-Al system has currently been developed. The one way shape memory alloy shows nearly 100% shape recovery at fairly high transformation temperature ($M_s \sim 100°C$). A two way shape memory alloy with quaternary element has been developed through a novel approach of precipitation induced transformation. A Memorandum of Understanding (MOU) has recently been signed by NML and SAIL(RDCIS) and by NML and DRDO (DMRL) for collaborative projects of mutual interest.

Significant contributions have been made in the development and testing of high temperature and creep resistant materials for thermal and nuclear power plants, fertilizer and chemical plants, etc. In close association with Bharat Heavy Electricals Ltd. the major user, four grades of such steels have been tested and developed and have been found to be acceptable as import substitute. NML is playing an ever increasing role in carrying out investigations on metallurgical failure and rendering advice to the industries. The NML processes for production of low alloy high strength weldable steels and of clad steels are available for commercial implementation.

In the field of extraction metallurgy, the laboratory has developed two processes for extraction of vanadium from vanadiferous iron ores and from the sludges obtained from alumina plants. Collaborating with Visvesvaraya Iron & Steel Ltd (VISL), NML demonstrated the process on melting of vanadiferous iron ores in the VISL plant. The process for extraction of vanadium from alumina sludge is under production. The commercial production of carbon-free ferro-alloys, adopting the laboratory's know-how, has resulted in reducing/eliminating their imports. The process for recovery of valuable tin metal from tin sludge has been very successful and is ready for exploitation. A single-step process of extraction of lead from lead concentrates, which has been tried out on tonnage scale, awaits industrial implementation. This process recovers sulphur as a sulphide avoiding pollution of atmosphere with sulphurous fumes.

NML technology for the production of electrolytic manganese dioxide (EMD) has been selected by Manganese Ore India Ltd., Nagpur (4000 tonnes/annum) and Magno Mining, Secunderabad (2500 tonnes/annum). A process for simultaneous production of EMD and activated manganese dioxide (AMD) has been developed which will be more economical in the pro-

duction of EMD. The process has earlier been transferred to T.K. Chemicals Ltd, Trivandrum and to Burma under the Indo-Burma Technical Cooperation Programme.

The technology for the production of the versatile aluminium alloy electrical conductor, NML-PM2, included in ISI specifications, is a major breakthrough in substituting copper: the product is in commercial production. The technology for the production of high strength medium conductivity aluminium alloy conductor NML-PM215 is under commercial production.

A plant (capacity 1000 tonnes/annum) of distilled zinc dust for use in zinc rich primers has been set up at Patna, based on the NML know-how. Atomized extrafine non-ferrous metal powders, ceramic filter for filtering molten aluminium and its alloys to get a clean melt free from oxide and dross inclusions and dental amalgam alloy for filling up dental cavities are being produced by the NML licencees.

The NML technology for graphite crucibles, widely used by ferrous and non-ferrous foundries and submerged arc welding fluxes is in production. The technologies for the production of clay-graphite stopper heads needed in steel plants for pouring hot metal to moulds dense carbon aggregate and soderberg paste are available for commercialization. The technologies for the production of heat-resistant cast iron alloy NML-Pyroloy 1000 and 'wear and abrasion resistant iron' are under various stages of implementation.

The laboratory conducts investigations on corrosion of metals and alloys in industrial plants, water pipelines, etc. and renders advice on preventive measures. Atmospheric corrosion of various metals under industrial and marine atmospheres has been investigated. The NML technology on aluminium based sacrificial anodes 'Superal' is in production. Processes on high output aluminium based sacrificial anodes, sulphuric acid and hydrochloric acid pickling inhibitor, copper pickling inhibitor, silicate base primer paint, etc. are in various stages of implementation. Multipurpose inhibitors have also been developed and the field trials at Tisco have shown that metal loss is much less when the devcloped inhibitor is used in place of conventional ones.

NML is producing various types of standard reference materials, imported hitherto, for chemical and spectrographic analysis.

The laboratory organizes symposia, seminars, etc. on subjects of topical interest; it also organizes get-togethers with industries, exhibitions, etc. The laboratory publishes NML Technical Journal (quarterly). It also publishes monographs, proceedings of symposia, etc.

A centre at Madras and four field stations besides a Regional Liaison Centre at Calcutta have been established by NML.

FIELD STATIONS

1. NML Madras Centre
   CSIR Complex
   P.O. TTTI-Taramani
   Madras 600113
   Telegram: CONSEARCH
   Telephones: 412077 & 412122
   Telex: MS-363

2. NML Field Station
   Industrial Estate
   P.O. Batala (Punjab)
   Telegram: REGFOS. BATALA
   Telephone: 417

3. NML Field Station
   Industrial Estate
   P.O. Baltikuri, Howrah
   Telegram: REGFOS. HOWRAH
   Telephone: 69-2866

4. NML Field Station
   Industrial Estate
   P.O. Naroda, Ahmedabad 382330
   Telegram: REGFOS. NARODA. AHMEDABAD
   Telephone: 826396

5. NML Marine Corrosion Research Station
   P.O. Digha, Dist. Midnapur
   West Bengal
   Telegram: REGFOS. MIDNAPORE
   Telephone: 40

6. NML Regional Liaison Centre
   4 India Exchange (7th Floor)
   Calcutta 700001
   Telephone: 223054
   Telex: Care 021/7432

NATIONAL PHYSICAL LABORATORY (NPL)

K.S. Krishnan Road, New Delhi 110012
(Estd 1950)

Telegram: NATPHYLAB

Telephone: 587161
Telex: 3726 & 5451

Director: Dr S.K. Joshi, M.Sc., Ph.D., F.N.A., F.A.Sc., F.N.A.Sc.

The laboratory carries out research and developmet activities in the areas of (i) Measurement Standards and Calibration; (ii) Electronic and Engineering Materials; (iii) Radio and Atmospheric Physics; (iv) Cryogenics and Superconductivity; (v) Applied Physics Projects, viz. thin film optical coatings, xeroradiography, high pressure metal forming, high power ultrasonic systems for oceanographic studies; and (vi) Theoretical Studies in Condensed Matter Physics.

Under the subordinate legislations of Weights & Measures Act, NPL has the responsibility of realizing the units of physical measurements under the International System, and of establishment, custody and maintenance of 'National Standards' of measurements representing these units (except for ionizing radiations, maintained at the Bhabha Atomic Research Centre, Bombay). These include the 'base' units, viz. 'metre', 'kilogram', 'second', 'kelvin', 'ampere', and 'candela' and various 'derived' units of force, pressure, vacuum, luminous flux, acoustics & ultrasonics, and various electrical and electronic parameters, viz. dc voltage, resistance, current and power; ac voltage, current, power and energy; and voltage, power, attenuation, impedance, frequency and noise in the high frequency and microwave regions. A recent development is the establishment of an interferometery manometer—a primary standard manometer for accurate measurement of barometric pressure. Work has recently been initiated on radiation standards in the infrared region of the spectrum and also on fluid flow measurements. Studies on the long term stability of the primary standard of mass have also been initiated.

The laboratory has built up considerable expertise, enabling it to shift from 'artefact' standards to 'quantum' standards. Currently, the 'second' is realized through a bank of cesium atomic clocks; 'metre' is based on iodine-stabilized He-Ne laser (operating at 633 nm, which is one of the internationally re-

commended wave lengths), and 'farad' is realized through a calculable capacitor linked with the length standard, and having 'ohm' and 'henry' traceable to it. Josephson voltage standard at 1mV level has also been established and work on primary standard of resistance based on Quantum Hall Effect has been taken up. Standard Time and Frequency Signals (STFS) are broadcast round the clock on all working days at three frequencies (5, 10 and 15 MHz) under the call-sign 'ATA' and a new dimension added to this service is the dissemination of STFS via INSAT-1B at a down-link frequency of 2599.675 MHz.

NPL undertakes calibration at the highest level of accuracy (Echelon I) in the country for various users such as government departments, defence, public and private sector industries, R&D institutes, etc. Under the programme of National Coordination of Testing and Calibration Facilities coordinated by the Department of Science and Technology, NPL has been given the responsibility of coordinating and implementing the calibration service in the whole country. Under the Calibration Service Programme, the traceability of the accuracy of all measuring instruments to the national standards maintained at NPL will be established through accreditation of cali bration laboratories.

International traceability of the national standards maintained at NPL is established through periodic calibration by the International Bureau of Weights & Measures, and intercomparison with national standards laboratories of other countries. NPL represents India on the General Conference of Weights & Measures (CGPM); and Steering Committee of the Asia-Pacific Metrology Programme.

Special emphasis is laid on the development of materials using indigenous raw materials. Various types of electronic materials, viz. ferrites, technical ceramics, piezoelectrics and dielectrics have been developed using the conventional ceramic technology. Current activities in this area include silicon technology, ultrasonic transducer materials and devices, luminous materials and devices, conducting ceramics, and carbon products.

An experimental pilot plant has been set up for making continuous carbon fibres. 2-D as well as 3-D carbon/carbon composites have been developed and tested by user organizations for biomedical and defence applications, respectively. Work

has also been initiated on development of flexible graphite for various applications. Laboratory-scale work to make pitch coke from commercial pitch, and coal tar for making impregnating pitch has been completed. Know-how has also been developed at a batch-scale level for production of aviation-grade brushes.

In the area of silicon technology, a process for preparing large area polycrystalline silicon ingots by directional solidification technique has been developed. The ingots thus grown are found suitable for fabrication of circular solar cells of 75 mm diam. and also of 50 mm×50 mm solar cells of 9-10% efficiency. Efforts are being made to develop, through collaboration with industry, 32 cm×32 cm×20 cm size (40 kg) ingots for 10 cm×10 cm cross-sectional area solar cells of 10-11% efficiency. Amorphous silicon solar cells of 1 cm^2 size have also been developed with an average efficiency of 6%. A novel technique of depositing newer amorphous silicon materials in cascaded reactors has also been developed. Studies on polysilicon, silicon dioxide and transition metal silicides are being carried out with a view to enhancing their understanding for microelectronics applications, and standard reference silicon materials are also being prepared.

The work of the laboratory in the area of TV phosphors has culminated in the preparation of a project report for a 30 tonnes/annum plant in collaboration with EIL, CEL and NRDC for transfer of this technology to the industry. In the area of Display Devices, studies on dynamics of polarization reversal and molecular reorientation process in thin ferroelectric liquid crystals have led to the observation of electro-optical colour switching. Extremely sharp electro-optical transmission characteristics, bistability and higher contrast ratio have been observed in large pitch cholestrics based on supertwisted bire-fringence effects. Metal-insulator-metal (MIM) two terminal thin film devices having non-linear voltage-current characteristics have shown freatures that may permit development of active matrix-addressed large area high information liquid crystal displays.

The laboratory has advanced facilities for characterization of materials in all aspects, viz. composition, purity, structure and perfection of atomic arrangement. The major facilities include: (i) Scanning electron microscope equipped with energy dispersive and wavelength dispersive spectrometers as micro-

probe analysis attachments (Jeol-JSM-35CF); (ii) Fourier transform infrared spectrometer (Digilab-FTS 20 E/U); (iii) X-ray fluorescence spectrometer (Rigaku-3070E); (iv) Atomic absorption spectrophotometer (Varian-Spectra A-10ABQ); (v) Electron paramagnetic resonance spectrometer (Varian-E-line Century Series); (vi) Gas chromatograph (Perkin-Elmer-Sigma 2000); (vii) Microprocessor controlled powder X-ray diffractometer (Siemens-D-500); and (viii) Transmission electron microscope with scanning attachment (Jeol-JEM-200 CX).

The laboratory has also developed a series of sophisticated equipment particularly for characterization of single crystals regarding perfection. Some of these are: (1) X-ray diffraction topography camera; (2) Microfocus X-ray generator; (3) Double, triple and quadruple crystal X-ray diffractometers; (4) Far infrared spectrophotometer (Fabry-Perot type); (5) X-ray stress analysis camera; (6) Low angle X-ray scattering camera; and (7) Volumetric absorption system for determination of surface area. The laboratory has also developed crystal pulling systems. These facilities are being further strengthened jointly with the Department of Electronics with particular emphasis on characterization of materials for electronics.

The Radio Science Group of the laboratory has, over the years, developed high level expertise in the area of atmospheric science. This includes radio propagation from very low frequencies to microwaves, and tropospheric, ionospheric and trans-ionospheric communications. It also covers monitoring of the atmospheric environment by radio, optical and other methods, as well as on long-term changes in the environment and in climate, and atmospheres of other planets. One special feature has been the study of atmospheric processes and chemistry. A number of problems of immediate application include study of rain microstructure, rain attenuation, and water vapour attenuation. A variety of experimental techniques are being used to characterize the radio meteorology of the Indian troposphere which includes kytoon, microwave refractometer, and fast-response rain gauges.

The group provides long and short-term forecasting of radio propagation conditions. It serves as the Associate Regional Warning Centre (ARWC), as a part of an international system of rapid exchange of solar, magnetic and ionospheric data. It is also involved in a scientific satellite payload programme in the

SROSS series. The payloads include retarding potential analyzer and energetic particle spectrometer for the study of energetics in low latitude ionosphere.

The Group is actively participating in the Indian Middle Atmosphere Programme (IMAP) which includes, among other things, rocket and balloon payloads for ionization, aerosol, nitric oxide and ozone measurement in the stratosphere-mesosphere, and a tunable carbon dioxide laser heterodyne system for atmospheric minor constituents measurement. This group is also actively participating in the International Programme of World Ionosphere and Thermosphere Study (WITS), and in the programme of establishment of the Mesosphere-Stratosphere-Thermosphere (MST) Radar as a national facility.

Another strong group of the laboratory is engaged in the area of Cryogenics and Superconductivity. Cryo-cooler for cooling infrared detectors at 77 K, based on Joule-Thomson expansion, and 4-5 litre per hour liquid air plant, based on Stirling cycle have been developed. Other development of cryogenic hardware include a 20-litre capacity liquid nitrogen container with an evaporation loss rate of 2% per day, liquid nitrogen pump and liquid nitrogen level detector.

In the area of Superconductivity, the laboratory has been doing R&D work both on the study of the phenomenon, and also on development of superconducting materials and devices. It has to its credit the development of the first superconducting magnet (5 Tesla) in the country along with the associated electronics for energizing it. Multifilamentary high field A-15 superconductors, viz. Cu-Nb_3Sn composite wire with an overall critical current density (J_c)=3×10^4 A/cm (at 4.2 K and 12 T field) and Cu-V_3Ga composite wire with J_c=7×10^4 A/cm (4.2 K, 6T) have been successfully fabricated. Work on development of SQUID is also on hand.

The efforts of the Group working in this area are, however, presently concentrated on development of high temperature superconductors following the discovery of yttrium-based mixed metal oxides, possessing superconducting transition temperatures of about 90 K, which has emerged as a global breakthrough having revolutionary technological implications. Within a few days of their announcement in March 1987, the Superconductivity Group at NPL successfully made several samples possessing transition temperature in the range

70 to 90 K. Work on fabricating composite wires of high T_c ($Y_1Ba_2Cu_5O_{7-x}$) compound has also been taken up Interestingly, for the first time, some of the quaternary compounds indicating the presence of a phase which remains superconducting up to the room temperature of +26°C, have also been developed. This has been confirmed by inverse ac Josephson effect studies.

The laboratory has, over the years, developed expertise in the area of Thin Film Coatings and Devices. Space qualified multi-cavity interference filters for ISRO, four optical components coated with dielectric thin layers for HAL, Nasik, and highly conducting copper coatings on ferrite rods used in phase shifters for DRDL, Hyderabad, constitute some of the achievements in this area. The filters developed by the laboratory have been used successfully in Rohini D-2 satellite and in ground-based radiometers. Expertise has also been developed in theoretical computation of multi-layer structures, and intricate designs for broad-band anti-reflection coatings and heat reflecting mirrors have also been developed. Technical know-how for production of antireflection coatings, interference filters, beam splitters, laser mirrors and neutral density filters has also been transferred recently to the industry.

The laboratory has to its credit the development of electrostatic copying machine using flat plate selenium photoreceptor. Based on the expertise developed, the laboratory has recently developed a xeroradiographic machine which is presently undergoing trials at the All India Institute of Medical Sciences, New Delhi. The machine gives X-ray prints on paper within a few minutes of the exposure, and will provide cheap X-ray facility to the common man.

NPL has set up elaborate facilities for hot extrusion, cold forging and synthesis of super-hard materials, e.g. single crystal diamonds and cBN compacts.

Among the newer areas of study undertaken, based on the expertise already developed by the laboratory in the field of piezoelecrics and ultrasonics, is the development of high power ultrasonic systems for oceanographic studies. Design and development of transducers for pingers, transducers and ocean acoustic tomography system has been taken up. Free-field condition has been established in a tube employing active impedance termination method for calibration of hydrophones having a depth capability of 250 metres in water. Pri-

mary ultrasonic transducers of frequency 300-350 kHz have also been fabricated for development of parametric system for detection of objects embedded in sea bed. Facilities for measurement of total ultrasonic power in the range 1 to 25 W and for intensity measurement in the frequency range 0.5 to 7.5 MHz have also been set up.

The laboratory has been an active participant in all the Indian scientific expeditions to Antarctica held so far—the major contributions being made by the Radio Science and the Time & Frequency Standards Groups.

The laboratory has a well equipped mechanical workshop, a glass workshop, and a library which also has a Patents Inspection Centre. Two computer systems VAX 11-780 and Zenith SC installed recently, constitute a common facility for all the R&D Groups of the laboratory. Increasing emphasis is being given to strengthen the information-based activities, viz. planning, monitoring and evaluation, international relations, seminars, training and technology transfer.

NPL publishes: *Ionospheric Data* (monthly); *Solar Geophysical Data* (monthly); *NPL Technical Bulletin* (quarterly); and *Sameeksha Sameeksha* (Hindi) (quarterly).

PUBLICATIONS & INFORMATION DIRECTORATE (PID)

Hillside Road, New Delhi 110012
(Estd 1951)

Telegram: PUBLIFORM Telephone: 586301

Acting Editor-in-Chief : Shri S. S. Saksena

The main function of PID is the collection and dissemination of information in regard to research as well as industrial matters. The current activities of PID include: (1) publication of scientific and technical literature—(a) research journals in various disciplines of science and technology, (b) encyclopaedias (*The Wealth of India* and *Bharat ki Sampada*); monographs and miscellaneous publications, and (c) newsletters, reviews and handbooks on CSIR activities; (2) publication of technical literature in Hindi and popular science magazines in English, Hindi and Urdu; (3) providing scientific and technical information services; (4) organizing courses in science editing and publishing; and (5) rendering production/printing assistance to other CSIR constituents, and agencies in bringing out their publications.

The directorate brings out 11 scientific journals, viz: (1) *Journal of Scientific & Industrial Research* (monthly), (2) *Indian Journal of Chemistry* (Section A) (monthly), (3) *Indian Journal of Chemistry* (Section B) (monthly), (4) *Indian Journal of Pure & Applied Physics* (monthly), (5) *Indian Journal of Technology* (monthly), (6) *Indian Journal of Experimental Biology* (monthly), (7) *Indian Journal of Biochemistry & Biophysics* (bimonthly), (8) *Indian Journal of Radio & Space Physics* (bimonthly), (9) *Indian Journal of Marine Sciences* (quarterly), (10) *Indian Journal of Textile Research* (quarterly), and (11) *Research and Industry* (quarterly). Each journal has an editorial board, constituted at intervals of three years, which functions as an advisory body with regard to the policies, scope and quality of the journal. The primary journals (2 to 9) are brought out in collaboration with the country's premier learned society, the Indian National Science Academy, and one of the journals (*Indian Journal of Biochemistry & Biophysics*) enjoys the additional patronage of The Society of

Biological Chemists, India. In order to facilitate quick noticing in international abstracting and indexing periodicals of research papers published in PID journals, an 'advance contents and abstracts service' is provided to the important abstracting and indexing periodicals and agencies. Two of the journals (1&5) are also available in microfilm form from the University Microfilms International, Ann Arbor, Michigan (USA).

The Wealth of India has been brought out in two series: Raw Materials and Industrial Products. Based on comprehensive literature surveys, this encyclopaedic publication comprises 11 volumes in the Raw Materials series (besides two supplements on 'Fish & Fisheries' and 'Livestock including Poultry') running into over 5000 pages and 9 parts of the Industrial Products series (consisting of 2800 pages), all of which have been published. In the Raw Materials series, the total number of entries is 5330, comprising 5196 on plants, 58 on animals and 76 on minerals. The Industrial Products series covers 255 industries which include 111 chemical, 79 engineering and 65 craft-based and miscellaneous industries. The revision work of the Raw Materials series is underway. The first volume of the revised series has been brought out and manuscripts for the second volume have been finalized and sent to press. Compilation work of Volumes 3&4 is in progress.

The directorate has set up a Research & Specimen Cell to help clarify certain nomenclatural and other problems relating to economic plants encountered in the compilation of *The Wealth of India*. At present, the cell houses 4500 herbarium specimens; 1350 raw materials of plant origin, 198 of animal origin and 185 of mineral origin. A project on preparation of permanent slides of economic plant raw materials for standard reference has been taken up. Also, a small laboratory has been set up for processing and identifying plant specimens. A library of photographs and drawings of economic plants collected over the years for *The Wealth of India* series has been housed in this section for reference and reproduction. In recognition of its rich collection, code RHMD (Raw Materials Herbarium & Museum, Delhi) has been allotted to this cell by Index Herbariorum, the world body of herbaria. The Cell supplies raw materials to the research workers, and others on request.

In the *Bharat ki Sampada: Prakritik Padarth* series (Hindi version of *The Wealth of India: Raw Materials* series), eight volumes covering the alphabets अ-सी, and two supplements entitled *Pashudhan aur Kukkut Palan* (Livestock including Poultry) and *Matsya aur Matsyiki* (Fish & Fisheries) have been published. The ninth volume of the series is under print. Other publications which have been brought out include: a dictionary of scientific names (names of genera and species separately) of plants and animals of economic importance with transliteration of their English and Latin pronunciation into Devanagari script, and a directory of scientific and technical publications in Hindi under the title *Hindi Vaigyanik aur Takniki Prakashan Nideshika: 1966-80.*

The directorate is the store house of more than 500,000 references suitably classified for easy retrieval, and of about 3000 information files on plant, animal, mineral and industrial products of India, which are kept 'alive' by adding information continually from current literature to be of use for *The Wealth of India.* Based on this collectanea, a specialized information service, known as Medicinal & Aromatic Plants Information Service (MAPIS), is being run. A bimonthly abstracting periodical, *Medicinal & Aromatic Plants Abstracts* (MAPA) is brought out as a part of this service. It reports current world literature in medicinal and aromatic plants from over 600 journals published in 22 languages from 50 countries of the world. MAPIS has attracted the attention of several international agencies such as UNESCO, ASCA, CAB, NTIS, and Royal Tropical Institute (Amsterdam). Bilateral collaboration has also been established with some member countries of the Association for Science Cooperation in Asia (ASCA) for sending their respective inputs for MAPA. PID has been identified by UNESCO as one of the potential information centres in the field of aromatic and medicinal plants and has been designated as one of the national nodes of APINMAP.

Another service rendered by PID is the Industrial Information Service under which technical enquiries relating to Indian industries are attended to. The quarterly *Research and Industry* is published as a part of this service.

Compilation of monographs on specific as well as composite topics relating to country's natural resources has been taken up. Monographs titled 'Diosgenin and Other Steroid

Drug Precursors' and 'The Useful Plants of India' have been published under this scheme. A second supplement to the *Glossary of Indian Medicinal Plants*, and *Wasteland Plants of India* are being compiled.

The directorate has brought out 12 botanical monographs and three zoological monographs, besides several miscellaneous publications including proceedings of symposia and books in different disciplines of science and technology.

The directorate brings out a semi-monthly house bulletin *CSIR News*, handbooks and souvenirs relating to CSIR, and status reports on S&T in India. *CSIR Samachar*, the Hindi version of *CSIR News*, is also brought out.

The Directorate publishes three popular science magazines: *Science Reporter* in Englsih (monthly), *Vigyan Pragati* in Hindi (monthly), and *Science ki Duniya* in Urdu (quarterly). Popular science books for children are also published.

All the indexes of PID journals are brought out using the in-house HP-3000 computer system. A database on medicinal and aromatic plants is being created, starting from the 1988 data, using the MINISIS package. The hard copy for printing of *MAPA* is produced from this database. The data on referees' rosters for the various PID journals are also being computerized.

The directorate maintains a well-stocked reference library, which has over 35,000 books, 15,000 reports and about 1000 periodicals in the field of science and technology. The directorate also has a documentation section and well equipped art, photography and production sections. It has in-house photocomposing and printing facilities, which include: Scantext photocomposing unit; offset printing machines; vertical process camera; Multiline-45 processor; automatic processor (Cronalith 24 L); and cutting, gathering and stitching machines. PID renders assistance in planning, editing and production of scientific and technical publications to CSIR laboratories, DST, etc., on payment basis.

Assistance is provided to the Bureau of Indian Standards in the preparation of standards pertaining to documentation, graphics and publication practices.

PID conducts short-term workshop-cum-training courses in science editing and publishing for the benefit of profes-

sional editors. Such courses are also organized by the directorate for the benefit of science editors in the South and Central Asian Region, under the auspices of Unesco. PID also provides training to science editors from developing countries, sponsored by IDRC, Canada.

REGIONAL RESEARCH LABORATORY (RRL)

Bhopal 462026
(Estd 1981)

Telegram: RESEARCH Telephone: 65690

Director: Dr Rajendra Kumar, B.Sc. (Met.Engg.), M. Met., Ph.D. D. Met. (Sheffield), F.I.E., C.E.

The laboratory has on its charter development of engineering metals, alloys and composites; building materials, aluminium technology and pollution control. The main research projects are on aluminium based composites, ceramic materials, building materials and metallurgical processing. Conforming with this, the laboratory is being groomed into a major centre for advanced research in materials on a multidisciplinary pattern. R&D activities are organized through divisions for Building materials; Powder metallurgy and contact materials; Melting technology and liquid state treatment; Tribology; Chemical and ceramics; Planning, liaison, information, research monitoring and computer applications; Scanning electron microscopy and X-ray; Pollution control; Optical microscopy and Failure analysis; Mechanical and physical characterization of materials; and Engineering services.

The laboratory has developed a technology for making aluminium alloy based composites for commercial applications like pistons and cylinder blocks for internal combustion engines and pump bodies. Extensive review has been carried out on mineral resources of M.P. in order to identify research, development and industrial imperatives. Work has been taken up on the development of ceramic tiles, high temperature insulation bricks, special ceramic membranes for water purification, glass ceramics, etc. In the area of building materials, work is being carried out on: (i) industrial wastes, (ii) fibre reinforced materials using synthetic and natural fibres, and (iii) building bricks from inferior soils.

Technical and consultancy services are being continuously provided by the laboratory. Studies are being carried out on metallurgical failure analysis for thermal power plants on sponsorship from different electricity boards.

Further work is envisaged in rapid solidification processing of materials, surface modification for tribological appli-

cations, thermomechanical processing, and development of ceramic particle fibres and whiskers especially those based on processing agrowastes.

Most modern facilities for undertaking R&D work in the broad discipline of Materials Science and Technology have been set up. These include: *Foundry*—Induction melting for aluminium melts, pressure die-casting machine, 150 T hydraulic press, heat treatment furnaces, compocasting machine. *Microscopy*—Leitz optical microscope with computerized TAS and image analyzer and a heating stage, JEOL (JSM 35CF) scanning electron microscope with double dispersive wavelength spectroscope and an energy dispersive spectroscope with a 512 kb computer. *Mechanical testing*—INSTRON universal testing machine, impact tester, microhardness tester. *Tribological testing*—cameron plint make friction and wear testing machine, rubber wheel abrasion tester, gas jet eroder, four ball tester for lubricants, Talysurf roughness measuring apparatus. *X-ray diffraction*—A 1700 series automated Phillips X-ray diffractometer with flat plate, Guinier and Debye Scherrer cameras, and goniometer. *Analytical instrumentation*—thermal analyzer (DTA, TGA, DTG up to 1500°C and DSC up to 675°C); infrared spectrophotometer, particle size analyzer, plasma emission spectrophotometer, single ion analyzer, hydrogen analyzer. *Polymers and Fibres*—LCR meter for electrical testing, impact tester, tensile tester, UV-VIS spectrophotometer, IR moisture meter, oxygen nitrogen index meter, ultrasonic tester, Keithley electrometer. In addition, the laboratory is equipped with microprocessors and microcomputers for R&D and management functions.

REGIONAL RESEARCH LABORATORY (RRL)

Bhubaneswar 751013
(Estd 1964)

Telegram: RESEARCH

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Telex: 0675-275

Director: Prof. P.K. Jena, M.Sc. (Chem.), Ph.D., M.Sc. (Met.), F.A.Sc.

The laboratory undertakes R&D work towards conservation and proper utilization of natural resources with special emphasis on minerals, metals and energy through processes and products development. The R&D activities of the laboratory are spread over the following nine areas: (1) Characterization of minerals, beneficiation of lean and complex ores and agglomeration of ore fines and concentrates; (2) Pyro and hydrometallurgical extraction of metals, preparation of alloys and recovery of metal values from chemical wastes; (3) Development of special materials and composites; (4) Designing of process equipment and control system; (5) Conservation of energy in metallurgical and chemical processes; (6) Hydraulic transportation of coal and other minerals; (7) Preparation and synthesis of organic chemicals of industrial and medicinal value; (8) Prepration of special catalysts and industrial inorganic chemicals from mineral resources; (9) Survey, introduction and cultivation of aromatic, medicinal and other economic plants.

The laboratory maintains a close interaction with industries, research and educational institutions of the state and central government organizations and entrepreneurs. Projects are taken up on sponsored/consultancy/collaborative basis at the instance of user industries and ministries. It conducts training programmes on senior level and extends analysis, information and library facilities to various concerned organizations. The planning and execution of R&D research programmes are being undertaken by different disciplines of the laboratory, viz. (1) Mineralogy and metallography. (2) Mineral beneficiation. (3) Pyrometallurgy. (4) Hydro and electrometallurgy. (5) Special materials. (6) Design and project engineering. (7) Inorganic chemicals. (8) Forest and marine products. (9) Aromatic and medicinal plants. (10) Cen-

tral physico-chemical and analytical facilities, and (11) Planning, information and library.

Over the years, the laboratory has made important achievements with regard to the development of processes and products which include: Mineralogical characterization and beneficiation of low grade iron, manganese, chromite, chinaclay, kyanite, andalusite, sillimanite, graphite, complex sulphide ores of copper, lead and zinc; Pan sintering of iron and manganese ore fines; Extraction of nickel and cobalt from nickeliferous laterite; Energy saving process for extraction of vanadium from vanadium bearing titaniferous magnetite; Energy saving roasting technique for production of sodium dichromate from chromite; Hydraulic transportation of coal and other minerals; Production of magnesium and potassium from marine bittern of the Orissa coast; Preparation of synthetic pigments from waste pickle liquor of steel plant; conversion of solasodine to 16-DPA; Production of yara-yara and Development of agrotechnology for commercial cultivation of palmarosa and *Solanum viarum*.

The R&D efforts of the laboratory have resulted in the setting up of sixty tonnes per day capacity pilot unit for iron ore sintering at Kalinga Iron Works, Barbil, Orissa; a pan sintering unit of fifty tonnes per day capacity for producing manganese ore fine sinters at the Ferro Alloys Corporation, Sriram Nagar, Andhra Pradesh; and an integrated pilot plant for generating engineering data for hydraulic transportation of coal and other minerals in the laboratory, in collaboration with the Engineers India Ltd, New Delhi. Facilities for testing the efficiency of combustion of furnace oil by a specially designed burner known as acoustic burner have been set up to generate data for designing and developing of commercial acoustic burners. Pilot scale facilities for high pressure leaching of ores and solvent extraction of non-ferrous metals for developing industrial processes and for agglomeration of ore fines and concentrates and testing of the products have also been set up in the laboratory in collaboration with GTZ, FRG. Demonstration plant has been set up in collaboration with the Ferro Alloys Corporation at their charge chrome plant at Boula, Orissa, to proudce 40,000 tonnes of chromite concentrates per annum.

The current R&D projects of national importance being pursued by the laboratory include: (1) An integrated project

on 'Mines—Metallurgy and Habitat (MMAH)' adopting recent technology in the area of mineral processing, agglomeration of ore fines, utilization of mine wastes for lowcost housing and roads, plantation of fast growing and commercial trees on mine dumps, mine water resource management and environmental protection at the chromite mines of Sukinda, Orissa and limestone mines of Mussorie, U.P.; (2) Setting up of a demonstration plant for recovery of coal fines from coal washery at Sudamdih washery by adopting flotation column, in collaboration with CMPDIL to work out the techno-economics for commercialization; (3) Pilot studies on hydraulic transportation of coal and other minerals and generation of data required for establishment of commercial units in collaboration with Engineers India Limited (EIL), New Delhi; (4) Development of improved fuel oil acoustic burners of large capacity (1000-1500 LPH) for oil economization in power plants and industries; (5) Setting up of large scale facilities for comparative evaluation of different techniques of agglomeration, viz. sintering, pelletization and briquetting and to study the behaviour of agglomerates during smelting for ferro-chrome preparation; (6) Development of a process based on beneficiation, pressure leaching, solvent extraction and electrowinning to recover copper, zinc and lead from complex sulphide ores of Ambamata, Gujarat; (7) Studies to develop techno-economically viable processes for the extraction of nickel and cobalt from the lateritic ore of Sukinda, Orissa; (8) Development and comparison of various processes for the extraction of copper, nickel, cobalt and manganese from manganese nodules of Indian Ocean origin; (9) Preparation of ferrous and non-ferrous alloys and special ceramic materials using plasma technology using indigenously fabricated plasma unit; (10) Extraction of metal values through bio-leaching of lean non-ferrous metal oxides and sulphides; (11) Setting up of a demonstration plant for the removal of toxic elements in coke oven effluents adopting fluid bed ion exchange system, at Rourkela Steel Plant, Orissa; (12) Development of various catalysts like multicomponent bismuth molybdate catalysts for propylene oxidation, catalyst carriers, preparation of perovskite catalysts for emission control and studies of manganese nodules as catalysts; (13) Process development for anti-TB drug namely pyrazinamide; and (14) Cultivation and populariza-

tion of elite cinnamom plant, agro-technology and genetic upgrading of *D. floribunda* and plantation of fast growing tree species.

The test and evaluation facilities at the laboratory include: large scale flotation column for beneficiation of various minerals and coal fines, gravity separation units including Bartle's Mozley concentrators and magnetic separators, agglomeration of ore fines and concentrates through sintering, pelletization and briquetting with facility for evaluation of the agglomerates, rotary kilns, multiple hearth furnace, high temperature Tamman furnace, vacuum induction furnace, etc. for roasting, smelting and melting studies, high pressure batch and continuous autoclaves for slurry leaching, solid-liquid separation facilities for generation of engineering data, special high temperature furnaces including plasma furnace for making alloys and composites, surface area, porosity, catalyst testing and evaluation, ion chromatograph, fluorescence measurement, analysis of ores, minerals, etc. by XRF, XRD and AAS techniques and IR, UV, GLC, HPLC, densitometer and different unit operations for carrying out bench scale work on organic chemistry.

REGIONAL RESEARCH LABORATORY (RRL)*

Hyderabad 500007
(Taken over in 1956)

Telegram: RESEARCH

Telephone: 853874
Telex: 0425-7061
ABC: RRLAB HD

Director: Dr A.V. Rama Rao, Ph.D. (Tech.), F.I.A.Sc., F.N.A.

The work of the laboratory is directed towards fundamental and applied chemistry and aims at the development of technological know-how and providing assistance in the establishment of chemical and allied industries.

The objectives of the laboratory are: (1) To carry out research and development work in selected areas of chemistry and chemical technology to develop process/product/design and engineering know-how; (2) To carry out R&D studies aimed at utilization of indigenous raw materials and resources with special emphasis on raw materials and resources available in the region; (3) To provide various types of technical assistance required in the setting up of chemical industry based on processes/products/designs developed by the laboratory; (4) To provide technical services like consultancy, design and engineering and analysis and testing; (5) To render technical advice to the government, whenever required; and (6) To carry out basic research in selected areas where the laboratory has built high scientific competence and is capable of making significant contributions to the advancement of knowledge.

The laboratory is the nodal agency for R&D work on agrochemicals. The R&D programme in this area includes development of indigenous technology for well identified pesticides of importance in current use and for future needs. The work also includes development of pesticidal formulation and generation of toxicity data. During the last decade, processes for the manufacture of monocrotophos, DDVP, diazinon, quinalphos and butachlor developed by the laboratory have already been commercialized. A capacity for 2000 tonnes/annum pesticides has already been established and capacity of 2600 tonnes/annum is under implementation based on the RRL technologies. Work is in progress for development of new and emerging pesticides,

*This laboratory has been renamed as Indian Institute of Chemical Technology w.e.f. 1 April 1989.

technologies for pheromones as a part of programme directed towards integrated pest management and biological control of certain pests.

Another major programme of the laboratory is the development of technologies for essential drugs, main objective being to work out innovative cost effective processes. The programme includes development of processes for vitamin A, drugs for various bacterial infections, including anti T.B. drugs and anti malarials. The work is at an advanced stage for development of antiviral agents such as azidothymidine, the only known drug against AIDS. Process development on flubiprofen, a new analgesic and anti-inflammatory agent has nearly been completed.

Two new drugs (methaquilone and Enfenamic acid) earlier developed by the laboratory have been commercialized. A potential analgesic and anti-inflammatory compound discovered by the laboratory is in phase II clinical trials.

The laboratory has been entrusted with major responsibility under the National Technology Mission on Oilseeds. Oilseed mission projects relate to rice bran, cotton seed, soyabean and salseed. A process for stabilization of rice bran and subsequent processing to obtain edible oil is being standardized.

Catalysis is one of the thrust areas identified by CSIR in which RRL is a participating laboratory. The programme includes development of oxychlorination catalyst and homogeneous catalyst. Ammoxidation of β-picoline to nicotino-nitrile and 2-methylpyrazine to 2-cyanopyrazine is another project in the area. The catalyst for the hydrogenation of benzene to cyclohexane, earlier developed by RRL, is in commercial production.

Rational utilization of low grade coals has been a major R&D programme of RRL. The present work is towards total gasification of coal. The studies are being carried out in a one tonne per hour pilot plant for pressure gasification. Based on extensive studies earlier carried out, a 900 tonnes/day low temperature carbonization plant has already been set up and is in operation for the last 8 years.

In the area of organic coatings and polymers, work is planned for the development of anticorrosive chemicals and coatings, adhesives and lowcost alternative building materials. Processes developed in this area, viz. manufacture of coatings based on cashew nut shell liquid, colloidal graphite and food emulsifiers are already in production.

In the area of intermediates, the laboratory is working for intermediates for drugs such as 2-aminobutanol, noval-diamine and intermediates for pesticides such as 2, 6 diethylaniline and *m*-phenoxybenzaldehyde. The laboratory has also undertaken developmental work on cyanuric chloride, an intermediate for dyes and pesticide industry. Intermediates like benzyl chloride and related chemicals, glyoxal and hydrazine hydrate, are in production based on the technologies developed by RRL.

Development of chemical processes for commercial exploitation being the prime objective of RRL, processes are developed at pilot plant scale to collect design data and designs are provided for commercial plants. Process design is supported by well equipped properties group. Expertise also exists in the field of simulation, optimization and control of chemical plants.

The laboratory brings out a quarterly news bulletin, annual reports and brochures.

REGIONAL RESEARCH LABORATORY (RRL)

Canal Road, Jammu-Tawi 180001
(Taken over in 1957)

Telegram : REGLAB

Telephones : 6368, 6383, 5540
PBX : 7641, 44382, 48551
Telex : 377-231

Acting Director: Dr C. L. Chopra, Ph.D.

The main objective of this regional laboratory is the industrial development of the north-western region by identifying and solving the problems of industry for optimal resource utilization and by exploration and exploitation of hitherto untapped resources of the region. This objective is sought to be achieved by development of new technology and by providing consultancy, testing, equipment design/fabrication and other allied facilities for productivity/quality gains, and through publication of scientific and technical literature.

A multi-disciplinary laboratory, it includes the disciplines of Chemical Engineering & Design, Natural Products Chemistry, Organic Chemistry, Process Development, Pharmacology, Tissue Culture, Isotope Laboratory, Applied Microbiology, Mutation Genetics, Plant Survey & Herbarium, Food Technology, Cellulose Pulp and Board, Minerals, Surface Coating, Rural Technology, Central Instrumentation, Industrial Survey and Technical Cell. The laboratory has pilot plant facilities in fermentation, phytochemicals, food, minerals, paper boards and surface coating.

The laboratory has a well-equipped workshop which fabricates equipment required for pilot plant studies of processes and also offers facilities to entrepreneurs in the design and fabrication of equipment required by them. As an instance of this laboratory's expertise in this field may be cited the fabrication of three plants for production of diosgenin from dioscorea. Two of these were for the governments of West Bengal and Tamilnadu and the third for the Central Research Organisation, Rangoon (Burma). In addition to above, a plant for production of menthol based on laboratory's know-how was fabricated for CRO, Burma and a plant for fractionation of Java citronella oil has been set up for the West Bengal Government.

The laboratory undertakes sponsored research related to its areas of activity. In addition, the technological needs of the small sector are identified through periodical surveys, research industry get-togethers, interaction with related development agencies, spot discussions with industrialists and through symposia and seminars. Technical queries from industrialists, entrepreneurs and those interested in the activities of the laboratory are attended to. The laboratory brings out a house bulletin *RRL Newsletter*, and annual reports, besides occasional books, brochures and booklets. An example is the recent publication of companion volumes on *Cultivation and Utilization of Medicinal and Aromatic Plants*.

The laboratory develops technologies for industries in the medium and large sectors. One of the salient achievements of the laboratory is the total utilization of pine. A turnkey job for utilization of pine needles for making of boards has been set up for Himachal Pradesh. An R & D project relates to the handling and distillation of resin, fractionation of turpentine oil into different components and their further conversion into value added products. Similarly, rosin is being converted into valuable products. The major research programmes of the laboratory are directed towards helping small industrialists and entrepreneurs. The current research programmes relate to microbial conversion of steroids, development of microbial products of industrial importance such as calcium gluconate, gibberellic acid and improvement in the process for production of vitamin C. Work on process development for production of important phytochemicals like 16-DPA, progesterone, colchicine, xanthotoxin, rutin, hyoscyamine, ajmalicin, and berberine hydrochloride has been completed. Development of new therapeutic agents from Indian plants is in hand. Recently, extract of gum resin of *Boswellia serrata* has been introduced as a drug in the market. A comprehensive programme on development of hepatoprotective agents is also in hand.

Basic studies on economic exploitation of the mineral wealth (clays, potassium from Tsokar lake, borax from Pugga, etc.) of the region have been completed. Other current research projects include : utilization of agro- and forest-wastes for fibreboards production, development of surface coating materials, development of insecticides of plant origin, economic utilization of synthetic juvenile hormone analogues of insects and production of boron compounds.

Projects bearing on rural development receive high priority, and these relate to : introduction, improvement and cultivation of medicinal and aromatic plants; development of fish and mushroom cultivation; raising of exotic species of rabbit, processing of sheep and fur skins; processing of fruits and vegetables, and design of solar driers for agro-horticultural crops.

The laboratory provides testing facilities with respect to drugs, essential oils, minerals and cellulosic materials. Work on biological standardization of pharmacological products is also taken up. Seeds, seedlings, planting materials and spawn for mushroom cultivation are supplied to interested parties. Short-term training courses in essential oil technology, fruit and vegetable processing and mushroom cultivation are also held. The laboratory undertakes market surveys for assessing the availability of raw materials and potential requirements of finished products. Preparation of techno-economic feasibility reports based on the technologies developed by the laboratory is also undertaken.

Branch Laboratory at Srinagar has further been up graded and new R&D activities have been added. Presently, work is being carried on hops, mushrooms, economic plants, fur and wool, temperate fruits, and silkworm. Hops and mushrooms growing based on agro-technology developed by branch laboratory is being done on commercial scale in the Kashmir valley. Total package for production of hops and its products is provided by the laboratory. The other projects being handled by branch laboratory also have direct bearing on the economy of the Kashmir valley.

BRANCH LABORATORY & FIELD STATIONS

1. Regional Research Laboratory
(Branch)
Sanat Nagar
Srinagar 190005 (Kashmir)

2. Regional Research Laboratory
(Extension Centre)
Palampur (Himachal Pradesh)

3. RRL Field Research Station
(Experimental Farm)
Chatha (Jammu Cantt.)
Telephone : 8536

4. RRL Field Research Station
(Experimental Farm)
Verinag (Kashmir)

REGIONAL RESEARCH LABORATORY (RRL)

P.O. Jorhat 785006
(Estd 1959)

Telegram: RESEARCH Telephones: 21317, 21353, 21972 & 21158
Telex: 0287-204 RRL IN

Director: Dr J.N. Baruah, Ph.D. (Texas)

The objectives of this laboratory are: (1) To put to effective use the immense material resources of the region and to develop the economy of the north-eastern region (NER); (2) To help NER in solving such problems of research as are confronting it; and (3) To take up long-range problems the solution of which would help in the economic development and industrialization of NER. The laboratory also functions as a link between the various organizations of the states and the union territory in NER and other national laboratories on problems requiring special attention.

The R&D work of the laboratory is organized in the following areas: Applied civil engineering, Chemical engineering, Coal, General engineering, Biochemistry, Inorganic chemistry, Medicinal and economic plants, Natural products chemistry, Organic (synthetic) chemistry, Drugs & pharmaceuticals, Papers and boards, Geosciences, Petroleum & natural gas, Analytical services, and Electronics & instrumentation.

The laboratory develops products and processes based on optimal utilization of mineral, agro-industrial, forest and energy resources in NER; and provides R&D inputs for introduction, acclimatization and propagation of indigenous and exotic medicinal and economic plants for extensive and profitable cultivation. R&D work on the high seismicity of the region is also covered by the laboratory's programme of work which includes setting up of a network of seismic surveillance stations in the generally earthquake prone NER.

Examples of projects bearing on mineral resources are those which relate to: low temperature carbonization of N.E. coal and its suitability in cement manufacturing, fluidized bed combustion of high sulphur coal, desulphurization of high sulphur N.E. coals, production of channel black from natural gas, improvement in curing technology for cold bonded pelletization, development of newer and effective additive for beneficiation of sinter grade fines/slimes, design and development of

Monocrotophos plant of NOCIL at Chiplun (Maharashtra), based on RRL, Hyderabad technology

Low temperature carbonization plant (900 tonnes/day) in Andhra Pradesh based on process and design provided by RRL, Hyderabad

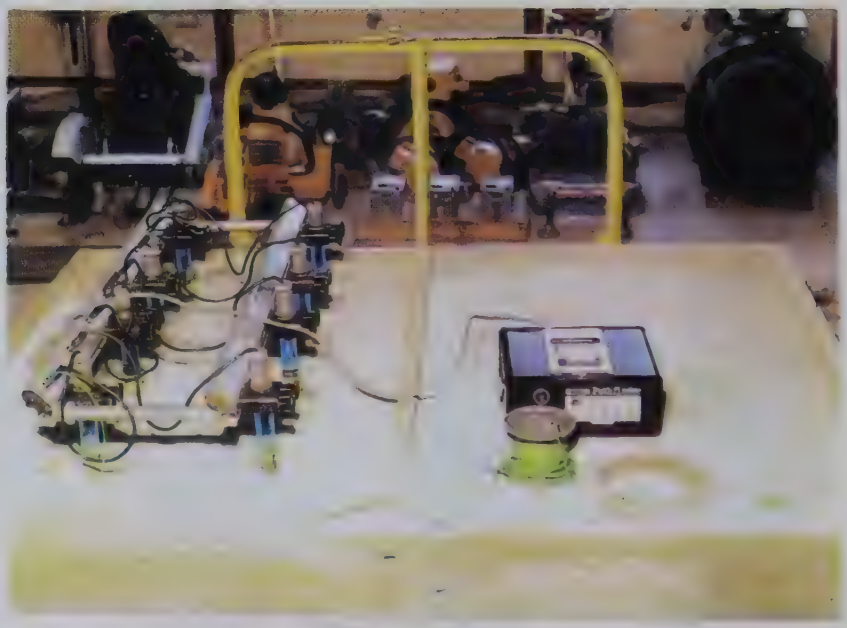
Hop yard : RRL, Jammu

Field view of Java citronella developed through plant tissue culture

Slurry transport through pipeline: RRL, Bhubaneswar

Demonstration plant for small scale palm oil extraction at Palode, Trivandrum: RRL, Trivandrum

Flexural test on a beam with varying prestress and eccentricity and curtailed prestressed reinforcement : SERC, Madras



Monitoring corrosion in reinforced concrete using half cells : SERC, Madras

vertical shaft kiln mini-cement plant, oil field chemicals, flow improver for pipeline transportation of high waxy crude, studies on microcrystalline wax and application of geomicrobiological technique for petroleum prospecting.

In the area of agro-chemicals, organic chemicals, drugs and drug intermediates, the projects are related to: development of know-how for pesticides, bioinsecticides against mosquitoes, isolation and characterization of compounds of plant origin with insecticidal and antifeedant properties, diosgenin from dioscorea tuber, hydroxy citronellol, citronella fractionation, studies on 2,1-benzisoxazoles and benzofuraxan oxides, pentazocine, bacterial plant growth promoter and studies of soil microbes, and chemical examination of *Eupatorium adenophorum*.

In the area of medicinal and economic plants, work is carried on: improvement, acclimatization and propagation of medicinal and essential oil bearing plants like citronella, dioscorea spp. and lemongrass, distillation and fractionation of citronella oil, and isolation of active principles from medicinal plants, agrotechnologies of edible mushrooms, tissue culture of bamboo, Java citronella and *Dioscorea floribunda*, plant improvement protection and testing, and plant physiological work. This also includes demonstration and training related to cultivation of medicinal and economic plants. The laboratory is also working on bamboo cultivation in the waste land and fast growing plants for paper industry.

The present areas of interest in paper and boards are: moulding powder from agro-industrial wastes; microencapsulated paper; self adhesive paper and tapes; and alternative fast growing plants for alternative fibrous raw material for pulp and paper industry. The laboratory's know-how for the following has already been commercialized: matrix board (stereoflong); matrix board for rubber stereo; correction paper; thermographic paper; direct copy paper and carbonless copy paper, paper slate, plastic slate and moulded slate; moulded plugs and jacquard board.

In biochemistry, the laboratory is working on the development of products like bromelain, high heat stable protease, active yeast, bacterial plant growth promoter, industrial enzymes, microbial fat, sterols and fats from sugarcane, soft wax and biogas from sugarcane pressmud. Geomicrobiological and geochemical prospecting for petroleum, biofertilizer pot-

ential of endotrophic mycorrhizal fungi in soils and weeds of north eastern region and development of bioinsecticides against mosquitoes are some of the currently investigated themes.

Projects investigated by the laboratory in the area of buildings and building materials concern production of cement by vertical shaft kiln (mini and tiny cement plants), corrugatged roofing sheets from agricultural wastes, cement-like product from paddy husk, ferrocement technique, use of locally available materials for low-cost houses; and evaluation of seismotectonic safety factors for sites in the region.

Laboratory's seismic studies in NER relate to: seismicity and microzoning; geodynamics with particular reference to the cause of earthquakes; and establishment and running of the seismic surveillance network of stations in collaboration with NGRI, Hyderabad.

Analytical services are extended to private and public sector undertakings. Specialized instruments are available and these include IR and UV spectrophotometers, proton NMR spectrometer, double focusing mass spectrometer, X-ray crystallographic equipment, gas-liquid chromatographs, electrophoresis apparatus, paint testing equipment and radioactivity assay instruments.

The laboratory is well-equipped with pilot plants, instrumentation facilities and the equipment required for carrying out various unit operations. The laboratory has a well equipped workshop in which facilities are available for carrying the design and fabrication of equipment required for R&D programmes of the laboratory.

Consultancy services are offered in: analysis of organic, inorganic and building materials; preparation of feasibility reports in selected areas of chemical industry; and site selection of buildings, bridges, etc.

In a number of research projects the laboratory has entered into collaboration with other R&D institutes to make the best use of facilities available within the country. It also accepts research projects sponsored by public and private sector undertakings and government organizations.

Basic and exploratory researches are taken up in a few selected areas such as chemistry of natural products, metabolism of hydrocarbons by microorganisms, and seismicity/geodynamics of NER.

The Planning Group formulates the research programmes of the laboratory, monitors and evaluates the progress in R&D and provides management support. It also extends support to the north-eastern states in science and technology formulation. The Information and Liaison Group maintains liaison with user industry and interacts with it in the licensing of processes and products developed by the laboratory.

The laboratory brings out its annual reports, *RRL News* (monthly) and current titles of research and review papers and general articles of relevance to its work.

RRL-Jorhat has established a branch laboratory at Itanagar in Arunachal Pradesh, which is carrying out work on introduction and acclimatization of medicinal and aromatic plants, chemical analysis of medicinal plants, testing of building materials and operation of seismic surveillance station.

RRL-Jorhat was identified as the 'lead laboratory' for an intercountry collaborative project on utilization of water hyacinth by Commonwealth Science Council and UNEP. The laboratory successfully developed a process for making good quality paper from water hyacinth and subsequently, a demonstration unit (50 kg/day) was established at Dhaka, Bangladesh.

The laboratory, with the sponsorship of the Department of Science and Technology, Government of India, has established a Science Motivation Centre and has organized science motivation courses for batches of selected students from NER.

Apart from the branch laboratory, the laboratory has five experimental farms and twelve seismic surveillance stations.

BRANCH LABORATORY

RRL-Jorhat Branch Laboratory
Naharlagun 791110
Itanagar, Arunachal Pradesh
Telephone 220

FIELD STATIONS

1. RRL-Jorhat Experimental Farms
   Yaongyimsen Village
   P.O. Changtongya
   Dist. Mokokchung
   Nagaland

2. RRL-Jorhat Experimental Farms
   Sepahijala
   Dist. Tripura
   West Tripura

3 RRL-Jorhat Experimental Farms
Montripukhuri
Dist. Imphal
Manipur

4. RRL-Jorhat Experimental Farms
Upper Shillong
P.O. Shillong
Meghalaya

5. RRL-Jorhat Sub-Station
Soil Conservation Training Centre
P.O. Senua, Tirap
Arunachal Pradesh

SEISMIC SURVEILLANCE STATIONS

1. RRL-Jorhat
Seismic Surveillance Station
Yaongyimsen Village
P.O. Changtongya 798613
Nagaland

2. RRL-Jorhat
Seismic Surveillance Station
P.O. Science College Campus
Kohima 797001
Nagaland

3. RRL-Jorhat
Seismic Surveillance Station
Transit Camp
P.O. Khonsa 786630
Arunachal Pradesh

4. RRL-Jorhat
Seismic Surveillance Station
c/o Deputy Commandant General
Mizoram Home Guard
P.O. Aizawl
Mizoram

5. RRL-Jorhat
Seismic Surveillance Station
RRL Campus
Jorhat 785006
Assam

6. RRL-Jorhat
Seismic Surveillance Station
P.O. Hamren
West Karbi-Anglong Dist.
Hamren 782486
Assam

7. RRL-Jorhat
Seismic Surveillance Station
Kaziranga Sanctuary
P.O. Kohora 785109
Assam

8. RRL-Jorhat
Seismic Surveillance Station
Durga Sorobar
Guwahati 781009
Assam

9. RRL-Jorhat
Seismic Surveillance Station
Haflong
Near Tourist Information Office
North Cachar District
Assam

10. RRL-Jorhat
Seismic Surveillance Station
West Kameng District
Bomdila 790001
Arunachal Pradesh

11. RRL-Jorhat
Seismic Surveillance Station
c/o RRL-Jorhat
Branch Laboratory
Naharlagun 791110
Itanagar
Arunachal Pradesh

12. RRL-Jorhat
Seismic Surveillance Station
Ouguri Hills
Tezpur
Assam

REGIONAL RESEARCH LABORATORY (RRL)

Industrial Estate, Trivandrum 695019
(Estd 1976)

Telegram: CONSEARCH

Telephone: 76774
Telex: 0435-232

Director: Dr A.D. Damodaran, Ph.D.(Leeds)

The objectives of the laboratory are to develop technologies for the optimal utilization of the resources of the region and to help the industries of the region through research, development and technology transfer. The laboratory also helps generate scientific knowledge, dissemination of information and training in related areas. The south-west coast of India has a wet agroclimatic condition that is ideal for the cultivation of spices and plantation products, rubber, tapioca, etc. which are almost unique to the region. The region also has valuable mineral resources such as heavy mineral sands containing zircon, ilmenite and monozite, and substantial deposits of lime shell, china clay and glass sands. Other resources such as red clay and laterite are also abundantly available.

The activities of the laboratory are essentially divided into three groups: (1) Research and Development programmes related to the natural products of the region, namely, starches and carbohydrates, spices, oil seeds like coconut and oilpalm, cashewnut shell liquid, etc. (2) Metallurgical and ceramic resources of the region, viz. rare earths, ilmenite and clays, and (3) Projects of strategic and national importance, e.g. advanced materials like special alloys and metal matrix composites, high temperature superconductors, etc.

The R&D activities of the laboratory are carried out in four divisions. The food division carries out research in the areas of post-harvest technology of spices and plantation products. The aspects covered are: improvement of processing techniques; development of value-added products; utilization of byproducts; development of new and improved techniques of extraction and modification of natural compounds; preservation and packaging of different spices; development of new coconut products having high value such as coconut cream and milk; processes for enhanced oil

recovery; production of semolina flour and food products from cassava, etc.

The activities of the Materials Division are aimed at developing new products utilizing the abundantly available agricultural and mineral resources of the region. These include: production of natural fibre-polyester composite materials, metal matrix composites and alloys, and value-added products from coconut shell liquid such as friction modifying polymers.

The Ceramics & Glass Division undertakes, in addition to R&D work on making glass and ceramic products from the locally available resources, development of building materials from laterite. The division also has programmes for the development of electronic ceramics.

The Systems Planning & Research Management Division is engaged in the planning, project evaluation, information dissemination, technology transfer and policy studies. The current R&D programmes/projects of the laboratory are related to: Quality aspects of cardamom (sponsored); Value-added products from spices and spice products; Processing aspects of coconut and oilpalm products; Utilization of cassava for industrial, fermentation and edible purposes; Processing of metal-matrix composites utilizing resources like sand, coconut shell, graphite and pith; Development of value-added polymeric resins/products based mainly on CNSL; Development of composite materials using coir/banana fabric, coconut leaves with polymer and cement matrices; Studies on the development of glass-ceramics utilizing industrial waste materials; Building materials based on lateritic soils of Kerala; and Studies on materials based on silica and industrial wastes.

Several of the laboratory's processes/products have been released for commercial utilization. These include: fractionation of chilli oleoresins, partially defatted coconut gratings, dry packed green pepper, white pepper powder by dry grinding method, bottling of coconut water for use as a soft drink, life extended coconut leaf thatch, and canning of green pepper.

An effluent treatment plant based on the laboratory technology was set up at Hindustan Latex Ltd. at its units at Trivandrum and Belgaum. A clay map of Kerala containing scientific evaluation and characterization of all major clay

deposits of Kerala has been produced in collaboration with the Department of Mining and Geology. A comprehensive study was made on the quality of Indian cardamom vis-a-vis the Guatemalan variety under the auspices of the Cardamom Board, Government of India. A demonstration plant for the extraction of edible grade palm oil has been set up in the CPCRI oilpalm plantation at Palode, as part of ICAR-CSIR collaboration for the national mission on oil seeds. A proposal is underway to establish a coconut processing facility at Lakshadweep Islands.

During the coming years, considerable emphasis will be placed on developing high level capabilities in the chemistry and metallurgy of rare earths as an integrated programme. Exploitation of other mineral resources like ilmenite, large scale development of metal matrix composites by improved fabrication techniques and effluent engineering relevant to the specific needs of the region are the areas in which the laboratory hopes to contribute significantly. Stress will also be given to the study of chemical modification of spice oil hydrocarbons to aroma compounds, extraction of flavours by sophisticated techniques like supercritical fluid extraction, microencapsulation of perfumery and flavouring materials, one step fermentation of cassava starch, etc.

The laboratory is well equipped to carry out: Chemical analysis of minerals and food materials, including flavour constituents, by gas chromatography and GC-MS; Evaluation of sands for use in foundry; Determination of physical properties of materials such as tensile strength, elongation and compressive strength; and Electron microscopy and X-ray diffraction analysis for materials characterization.

The laboratory brings out its annual reports.

STRUCTURAL ENGINEERING RESEARCH CENTRE (SERC)

Ghaziabad 201001
(Estd 1965)

Telegram: SERCENTER

Telephones: 8-42208 &
8-42026
Telex: 0592-204 SERC IN
0592-294 SERC IN

Director: Dr S P Sharma, B Sc. (Engg), DIC, Ph D (London) M I A S S
M.I.A.B.S.C., F.I.E. (India), M.C.S.I.

The scope and functions of SERC-Ghaziabad are: (1) To act as an information bank for the latest available knowledge and know-how relating to the design and construction of the wide range of structures and structural systems; (2) To undertake application-oriented research on all aspects of structural engineering in consonance with national priorities; (3) To take up sponsored R&D work for organizations in the public and private sectors, especially with regard to developing optimal structural designs using electronic computers, tests on scaled models and prototypes, field measurements, etc; (4) To undertake selective consultancy assignments involving analysis and design of complex structures; (5) To organize periodically short-term specialized courses in structural engineering disciplines with a pronounced practical bias, to expose practising engineers to new ideas and techniques; and (6) To develop comprehensive computer software for structural engineering applications.

Over the years, the endeavour of the Centre has been to gear its research activities to the developmental needs of the country in the field of structural engineering. Towards meeting this goal, it has built up capabilities in several frontier areas such as those related to optimum design of repeat structures, using modern computer-aided optimization techniques, resulting in economy in terms of time and labour; Accurate computer analysis of very complex and sophisticated on-off structures, such as satellite tracking antennas and cable stayed bridges, taking into account such aspects as non-linear behaviour and dynamic effects; and Integrated approach to design, treating the structural system as a whole, taking into consideration such phenomena as dy-

namic effects, time-dependent behaviour, non linearity and soil structures interaction.

The major thrust areas of the Centre include: highrise buildings, long span structures, underground structures and computer software. The current R&D projects of national importance being pursued cover: analysis and design of box girder free cantilever bridges for developing guidelines for their design; studies on dynamic response of bridges for understanding the vehicle-bridge interaction, under factors inducing dynamic loading; studies on infilled frames for evaluating the contribution of infills to the strength and stiffness of multi-storeyed buildings, taking into account the soil-structure interaction; non-linear analysis of structures subjected to static and dynamic load, for developing the related software packages; development of efficient machine independent software packages concerning non-linear optimization problems in structural engineering, development of optimization design of reinforced concrete overhead water tanks, and the related software; and probabilistic studies in the limit state design of concrete buildings for bringing about reliability of design criteria for the limit states of safety and serviceability.

The Centre has taken up the following sponsored projects of national importance: (1) Instrumentation of Reactor Building-1 of Narora Atomic Power Plant and assessment of its structural behaviour during pressure test, (2) Performance studies of the super structure Taj Mahal, and (3) Development of computer software for the Ministry of Transport.

The Centre has brought out a number of handbooks with a view to helping designers in the selection of sections for prestressed concrete components using limit state methods, slabs by yield-line and strip methods, and machine foundations.

The Centre has done pioneering work in developing ferrocement components for a wide variety of uses such as bins, water tanks and gas holders for *gobar* gas plants. The SERC know-how has been acquired for commercial exploitation by 28 firms through National Research Development Corporation of India.

CSIR has assigned a unique task to SERC for the development of suitable water storage system using ferrocement technology developed at SERC, rain water collection system

for use in high rainfall areas, and storage structures for hill areas. SERC is also conducting training courses for various levels of officers, for building systems for rain water harvesting and storage under the Drinking Water Mission project. It has organized a series of courses at Roorkee, Ghaziabad and Manipur and is planning to hold such courses in very remote places and states including Andaman and Nicobar.

A low speed wind tunnel is being set up to study the wind effects on complex structures, i.e. tall structures and long span bridges with the help of model tests and lay guidelines for the designers. The Centre is also likely to procure soon a TATA ELXI main frame computer facility.

The Centre has recently shifted from Roorkee to the campus at Central Government Enclave, Sector 19, Ghaziabad. The new laboratory building is under construction.

STRUCTURAL ENGINEERING RESEARCH CENTRE (SERC)

CSIR Campus, Taramani, Madras 600113
(Estd 1965)

Telegram: SERCENTER

Telephones: 412139, 412343 & 412175
Telex: 41-6876 CSIR IN
41-8798 TTRS IN

Director: Dr M. Ramaiah, B.A., B.E. (Hons), M. Tech. (Struct. E), Ph.D., M.I.A.S.S., F.I.E. (India)

The objectives/functions of the Centre are: to act as a clearing house for the latest available knowledge and to develop know-how on design and construction of all types of structures; to undertake application-oriented research in all aspects of structural engineering—both design and construction; to provide design consultancy services to organizations in the public and private sectors in developing a variety of structural designs; and to organize specialized courses on structural engineering and digital computation for the benefit of practising engineers to familiarize them with the latest developments in analysis, design and construction.

The current research areas/projects of the Centre are: studies on nonlinear and dynamic response of hyperboloid cooling towers subjected to wind and transient loadings; development of construction techniques and concrete products; standardization of prestressed concrete components; investigations on fatigue behaviour of steel offshore structures; stochastic mechanics and reliability analysis of offshore structures; studies on experimental stress analysis techniques and their applications; computer-aided design and software development; dynamic response of structures with particular reference to machine foundations; development of computer software packages for dynamic analysis of structures; studies on the effect of non-prestressed reinforcement in prestressed concrete members; development of interactive computer graphic systems; analytical and experimental investigation on transmission line towers and tower like structures; development of special concretes and concrete composites; development of an expert system for free-standing steel lattice microwave and transmission line towers; dynamic response analysis of ship hull structures, and

analysis, design and construction of wind disaster resistant structures.

Several of the projects undertaken by the Centre have led to the development of new products, technologies and applications. Some of these products and processes have been patented and/or commercially exploited. Of these, mention may be made of the development of deformed bars for concrete reinforcement, indigenous technology for the manufacture of prestressed concrete railway sleepers, a simplified process for the manufacture of prestressed concrete poles, industrialized systems of construction, waffle shell systems for roofs and floors, designs for lowcost houses, polymer concrete formulation for repairs and special applications, and ferrocement technology for the production of building components. New products such as lateritic soil blocks, fibre reinforced concrete manhole covers, and polymer concrete composites have also been developed based on extensive investigations.

The Centre has a Prime 750 computing system, and has developed several computer programs for the analysis and design of plane and space frames, shells and folded plates, power plant structures, transmission line towers, cable-supported structures, machine foundations, industrial structures, etc. Many application programs such as TAPS, OSTA, CODES have been developed for Tower Analysis, Offshore Structures, and Ship Structures.

Computer-aided design and interactive graphics is another area in which the Centre has recorded significant progress, especially in the last two years. A number of programs have been developed indigenously for analysis, design and drafting in an interactive mode.

Highly sophisticated facilities including laser holography and speckle interferometry have been built up for experimental investigation of structures subjected to both static and dynamic loads.

The Centre is setting up a full fledged fatigue testing laboratory with facilities for on-line, servo-controlled electrohydraulic fatigue testing system for conducting fatigue and dynamic tests on models and components.

The analysis and testing of structural models and prototypes are undertaken by the Centre in several of its laboratories devoted to: Heavy testing, Experimental stress analysis,

Concrete testing, Composites, and Structural dynamics. The Centre also has a modern and automatic tower testing and research station. An out-door casting yard equipped with a 80 tonne-meter tower crane, and an instant steam boiler for steam curing are also available. The Centre had been receiving valuable assistance from UNDP/UNCHS for augmenting its facilities.

The Centre offers consultancy services to public and private sector organizations on a selective basis to propagate innovative designs and construction techniques, resulting in economy in cost and material. It has a fully equipped drawing office. A team of highly qualified scientist-engineers with vast experience in the analysis and design of complex structures forms the nucleus for undertaking specialized consultancy referred to by the industry from time to time.

The Centre organizes training courses every year in several areas of structural engineering to provide continuing education to in-service engineers to keep them abreast of the latest advances in the field of structural engineering.

ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION (ERDA)

Office: Brabourne Stadium, 87, Veer Nariman Road, Bombay 400020

(Estd 1978)

Telegram: ELECSEARCH

Telephone: 220622
Telex: 011-6742

Laboratories: Makarpura Industrial Estate P.O., P.B. No. 760, Vadodara 390010

Telegram: ELECSEARCH

Telephones: 42613, 42942, 42964, 43177
Telex: 175-625

Director: Shri R.H. Buch

ERDA is a National Co-operative Research Association of the Electrical Industry and Utilities, recognized by CSIR and Government of Gujarat as a grant-in-aid institution. ERDA is devoted to applied R&D in a wide spectrum of electrical engineering disciplines. Its objectives aim at promotion of technological development, and include better utilization of existing materials, improvements in materials and equipment, failure investigation of equipment, calibration, standardization and dissemination of technical information. The activities of ERDA are of particular assistance to small and medium scale industries.

R&D activities of ERDA are carried out in three divisions: (1) Insulation, (2) Materials and (3) Products, besides a Documentation Centre. A membership liaison office functions at Bombay. The R&D programmes undertaken with the existing facilities fall in the following areas: (1) Characterization of insulating, conducting, contact, magnetic and structural materials for electrical industry, (2) Failure analysis in respect of electrical equipment and systems; (3) Economy and reliability studies of power system; and (4) Type, developmental and special testing and quality assurance of electrical equipment.

The major facilities established are for: Ingress protection (IP) for verification of protection provided by the enclosures of electrical equipment against ingress of pollutants; Impulse tests on transformers, reactors, bushings, etc; Evaluation of pumps, motors, domestic electrical appliances, switchgear,

capacitors, fuses, lamps, etc; Electrical, mechanical and thermal endurance; Instrumental analysis consisting of gas and liquid chromatography, thermal analysis and spectrography; Flammability/fire resistance, ultraviolet weathering, dissolved gas analysis, etc. and Metallography, electrical, mechanical and magnetic properties, corrosion, NDT, failure analysis.

ERDA meets the R&D needs of electrical industry. Some of the important projects recently completed/in progress are: Functional life test evaluation of distribution transformers; Development of 10 A drop out fuse element; Reliability studies of power station auxilliary drive motors; Determination of optimum drying cycle for PT coils; Evaluation of enamelled wire/impregnating compound compatibility and Evaluation of safety and quality aspect of selected electrical appliances.

Besides, ERDA carries out failure analysis and evaluation work for a number of undertakings such as Railways, Electricity Boards, ONGC, GSFC, etc.

Documentation Centre of ERDA disseminates current technical information through its abstract service, literature surveys, state-of-art reports, etc. The quarterly publication *ERDA News* disseminates information about facilities, R&D projects and other technical activities.

Knowledge updating is another important function, which is carried out regularly through organization of seminars/workshops/courses/industry get-togethers, etc.

TEA RESEARCH ASSOCIATION (TRA)

Head Office: 113, Park Street (9th floor), Calcutta 700016
(Estd 1964)

Telegram: TEADVANCE Telephone: 29-1815

Tocklai Experimental Station (TOCKLAI), Jorhat 785 008

Telegram: SCIENCITA Telephone: 20038 Jorhat

Director: Dr R. Singh

The objective of the Tea Research Association is to carry out and promote research work connected with the cultivation, production and processing of tea and to disseminate the results among the member tea estates of North-east India. The association caters to the needs of about 800 tea estates of the region, identifies the constraints and removes them. The research work is of both fundamental and applied nature; the emphasis is given to play an effective R&D role to increase the productivity and maintain the quality of tea as a product. This is carried out at its field station known as Tocklai Experimental Station (popularly known as 'Tocklai').

Tocklai has seven research departments: Soils and Meteorology, Botany, Agronomy, Plant Protection, Biochemistry, Tea Technology & Manufacture and Statistics & Agriculture Economics. Eighteen projects are underway in the following areas: bio-technology, water management, tea machinery development, plant improvement, plant nutrition, pruning & plucking, stand density and planting pattern, young tea management, shade & shade trees, biology and control of pests of tea and ancillary crops, biology and control of disease in tea and shade trees, weed control, chemistry of tea, tea processing, tea packaging and storage, methodology of experimentation, surveys and study on tea economics.

In addition to the research departments, the Advisory Department with its extension network throughout the tea districts deals with extension research and technology transfer at field level and with regional problems. A pilot plot sponsored by Tea Board of India has successfully developed the instant tea from green leaf which is being sold for commercial utilization of the product.

The infrastructural facilities at Tocklai include a planning cell to facilitate operative aspects of research planning and liaison and also monitoring of projectized research; a library and publication section; about 300 ha of experimental farms equipped with multi-faceted experimental facilities at Tocklai and Borbhetta and another 30 ha at outstations; two miniature tea factories one each at Tocklai and Darjeeling; an engineering workshop and a 32 bit computer.

Activities of Tocklai are guided and monitored by the Council of Management of TRA consisting of 24 members of whom 17 are elected by the industry, the rest being the representatives of CSIR, ICAR, Tea Board and Indian Tea Association. A Scientific Advisory Committee consisting of eminent persons of science and technology in India advises the Council of Management on R&D programmes for Tocklai. A Tasters' panel, drawn from industrial houses in London, Calcutta and Guwahati helps the Tea Technology & Manufacture department. TRA maintains a close link with the industry through three sub-committees, one each concerned with agriculture, tea technology & manufacture and economics. At field level, the liaison is maintained through nine committees of planters (called Area Scientific Committees) which organize quarterly meetings in different areas. Further, visits of specialists and advisory officers to tea estates help Tocklai in maintaining a constant touch with the industry and in identifying the problems faced by it both in the field and the factory; these problems are referred to appropriate research departments for devising ways and means for their solution and are reflected in the research programmes of Tocklai. In addition, biennial conferences and joint area scientific committee meetings are held for planters and tea scientists to review the progress of work made by Tocklai.

The pioneering research carried out by Tocklai has contributed towards all round development of the industry. TRA members' average yield in 1985 was 60% higher than that of the non-members in N.E. India. Tocklai has developed vegetative propagation method for tea and has so far released 44 very high yielding quality clones and six improved seed stocks besides producing modern know-how to the member estates for producing 57 additional clones. New methods of skiffing, pruning and tipping techniques have revolutionized the tea cultivation. Proper water management, soil rehabilitation

techniques and field technologies developed at Tocklai have contributed towards improving yields. Studies on macro and micro nutrients have enabled the optimization of these inputs. Techniques and technologies for integrated control of pests, diseases and weeds have been standardized. Physiological significance of shade trees for N.E. India has been established through fundamental studies. These developments have resulted in better cultivation, which in turn, has been reflected in reaching high productivity levels.

In tea processing, the machinery developed at Tocklai is being used the world over. These include: McTear-rotorvane, continuous tray tea drier, withering tunnel, Borbora leaf conditioner and cutter attachments, continuous fermenting machine and Boruah continuous tea roller, to name a few.

For effective transfer of technology and dealing with regional research and extension problems, Tocklai maintains a substation at Nagrakata in Dooars (West Bengal) in addition to six regional centres located one each at Terai, Darjeeling (West Bengal), Cachar, North Bank of Brahmaputra, Dikom (Upper Assam) and Agartala. North Bank, Cachar, Dikom and Darjeeling centres have been developed and equipped for extending regional soil testing facilities, and also conducting field research on regional problems.

Apart from rendering advice pertaining to economy and efficiency in tea fields and factories, Tocklai carries out soil tests for recommending fertilizers, water tests for ascertaining suitability in tea manufacture, calibration of tea moisture meters as well as testing of a variety of materials used in manufacture and growing of tea. It identifies pests and diseases for their control and also sees to the elimination of pesticide residues, taints, iron filings or insect fragments from made tea. Further, it undertakes testing and evaluation of pesticides, herbicides, fungicides and other agricultural chemicals, and spray equipment for determining their functional efficacies. This service is offered to input suppliers who are associate members of TRA.

Tocklai runs in-service training courses for tea planters on different aspects of tea culture, surveying and drainage, field management and tea economics. It also helps in growing tea in new and non-traditional areas by providing appropriate package of practices for cultivation and processing of tea.

Tocklai publishes: a six monthly journal—*Two & A Bud*; a reference handbook *Tea Encyclopaedia for Tea Planters* con-

taining up-to-date information on different aspects of tea growing and manufacture; annual scientific reports; advisory bulletins & leaflets, special bulletins; occasional scientific papers; memoranda and bimonthly/quarterly news bulletins from out-stations and proceedings of Tocklai conferences.

ADVISORY DEPARTMENTS/SUB-STATIONS

1. Upper Assam Advisory Department
   Dikom 786101, Assam
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   Telephone: 67

2. North Bank Advisory Department
   Thakurbari 784503
   Darrang, Assam
   Telegram: Advice-Thakurbari
   Telephone: Rangapore 56 & 122

3. Cachar Advisory Department
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   Cachar, Assam
   Telegram: Advice-Silcuri
   Telephone: Silchar 1038

4. Tripura Advisory Centre
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   Agartala 799001, Tripura
   Telegram: Advice-Agartala
   Telephone: Agartala 1579

5. Nagrakata Sub-Station
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   Jalpaiguri
   West Bengal
   Telegram: Advice-Nagrakata
   Telephone: Nagrakata 73

6. Terai Advisory Branch
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   Salugara 734402
   Jalpaiguri, West Bengal
   Telegram: Advice-Siliguri
   Telephone: Siliguri 20154

7. Darjeeling Advisory Branch
   11, Coochbehar Road
   Darjeeling 734101, West Bengal
   Telegram: Advice-Darjeeling
   Telephone: Darjeeling 2070

Appendix

POLYTECHNOLOGY TRANSFER CENTRES (PTCs)

	Address	Telegram Telephone Telex
PTC, Ahmedabad (1975)	CSIR Polytechnology Transfer Centre O-17, New Mental, Asarwa Ahmedabad 380016	CONSEARCH, Ahmedabad 376085
PTC, Hyderabad (1975)	CSIR Polytechnology Transfer Centre Directorate of Industries Compound, Chirag Ali Lane Hyderabad 500001	POLYCLINIC, Hyderabad 225107 0155-261 RRLH IN
PTC, Bangalore (1976)	CSIR Polytechnology Transfer Centre 2nd Floor, Rastrothama Parishat Bhavan, 14/3, Nrupathunga Road Bangalore 560002	CONSEARCH, Bangalore 27464 0845-279 NAL-IN
PTC, Patna (1976)	CSIR Polytechnology Transfer Centre 2nd Floor, Udyog Bhavan East Gandhi Maidan Patna 800004	POLTECH, Patna 50134
PTC Trivandrum (1976)	CSIR Polytechnology Transfer Centre Medical College Road, Pattom Trivandrum 695004	POLYTECHNOLOGY, Pattom 62214 022-289 BEDC IN
PTC, Bhopal (1977)	CSIR Polytechnology Transfer Centre Block A (West) Guru Tegh Bahadur Complex, Roshanpura Bhopal 462003	CONSEARCH, Bhopal 63090
PTC, Lucknow (1979)	CSIR Polytechnology Transfer Centre C-46, Nirala Nagar Lucknow 226007	TECHTRANS, Lucknow 74083 0535-286 CDRI IN
PTC, Calcutta (1979)	CSIR Polytechnology Transfer Centre 4, India Exchange Place 7th Floor Calcutta 700001	POLYSERVE, Calcutta 223508 021-7432
PTC, Shillong (1979)	CSIR Polytechnology Transfer Centre Ryongi Tyriew, Upper Nongthymmai Shillong 793014	CONSEARCH, Shillong 26805

(Note: Correspondence with PTCs may be addressed to Project Officers in charge.)

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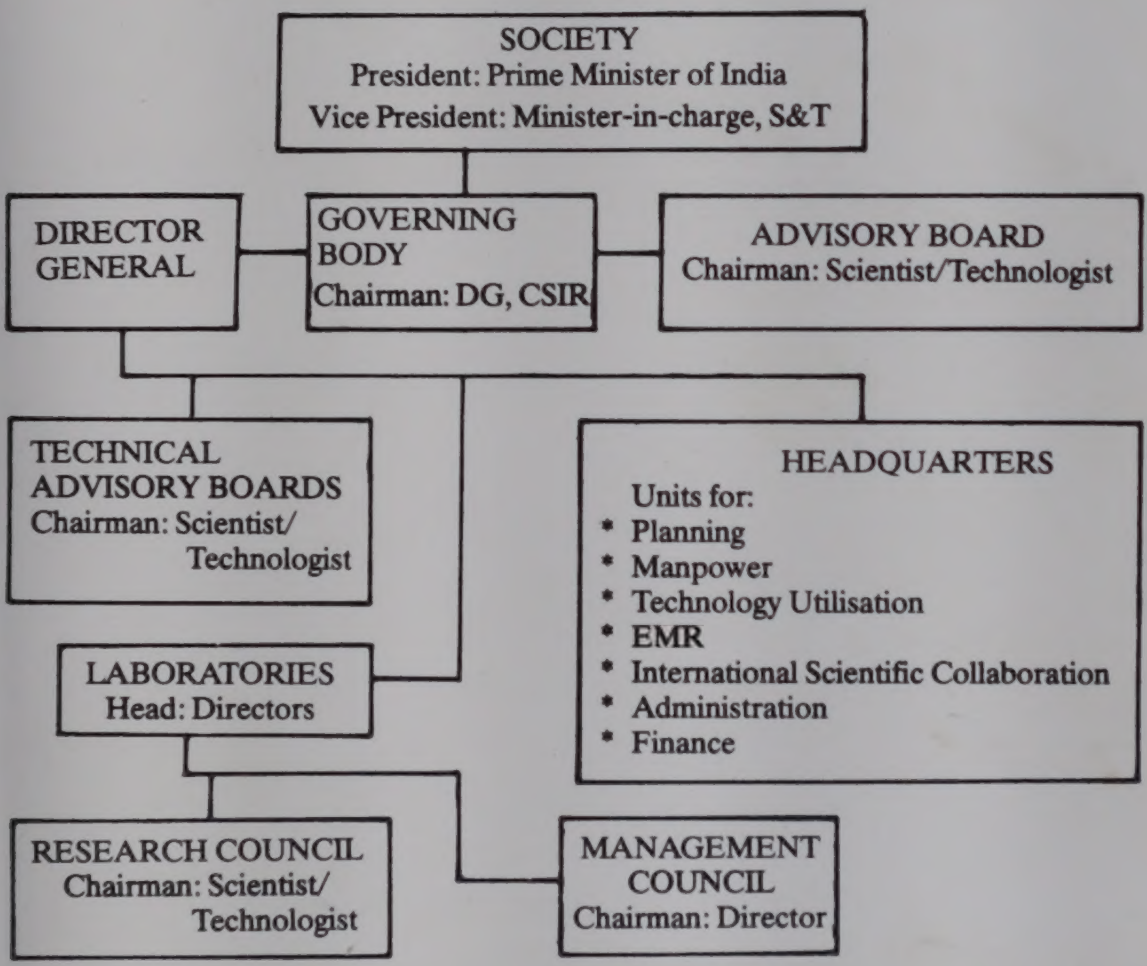
ORGANIZATIONAL STRUCTURE



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